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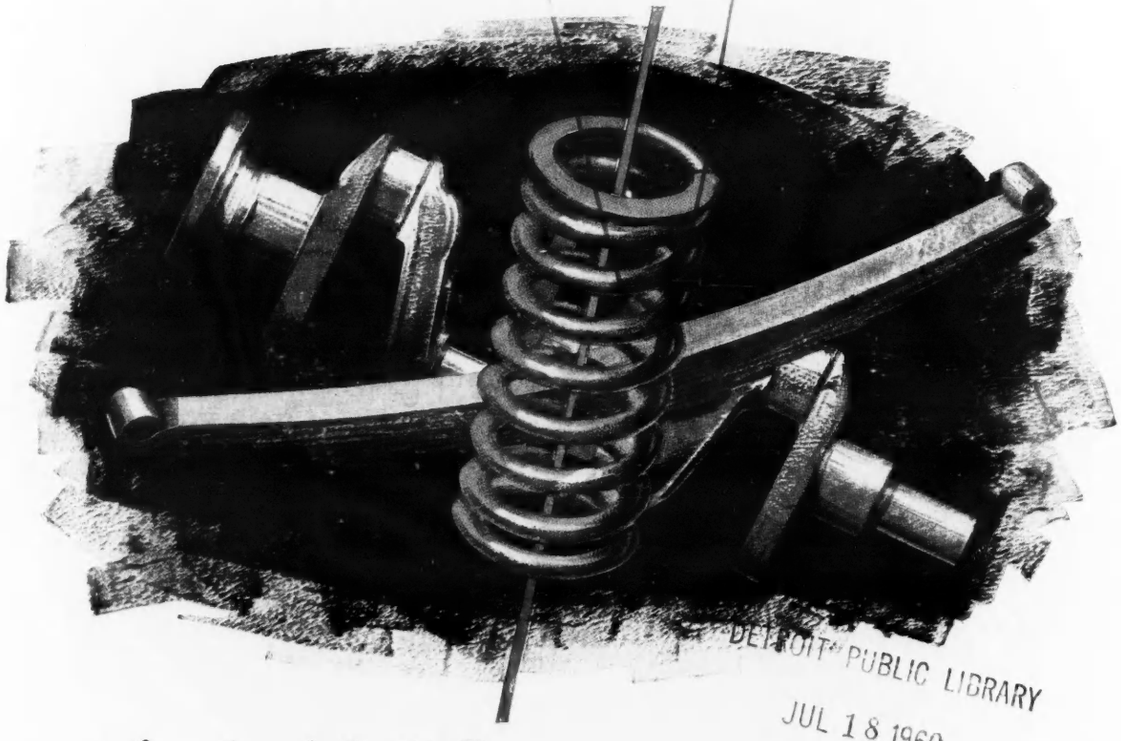

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No. 5449 JULY 1, 1960 VOL. 210

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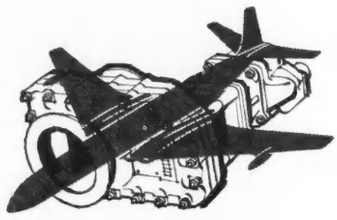

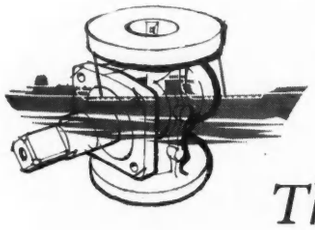

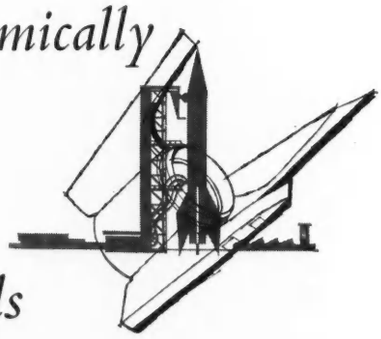

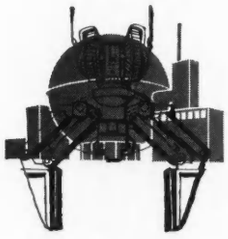

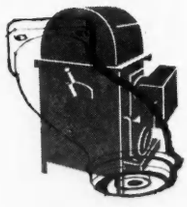

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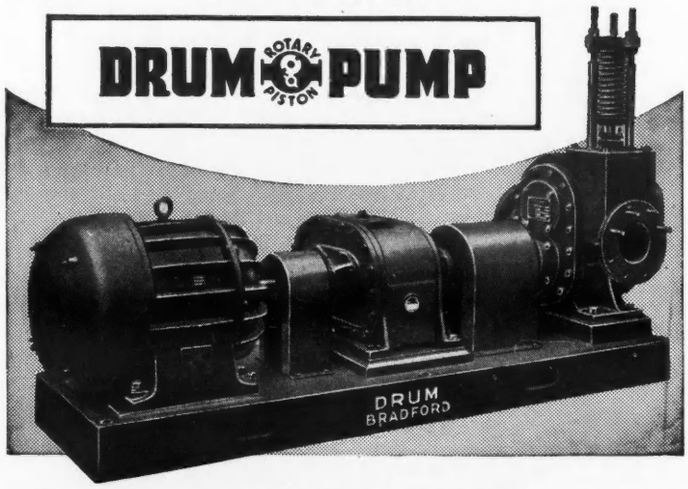

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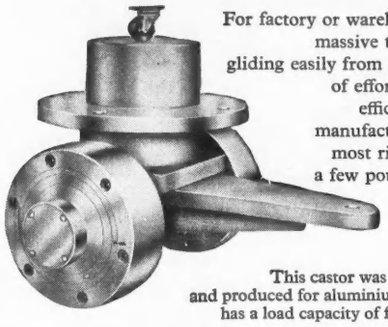

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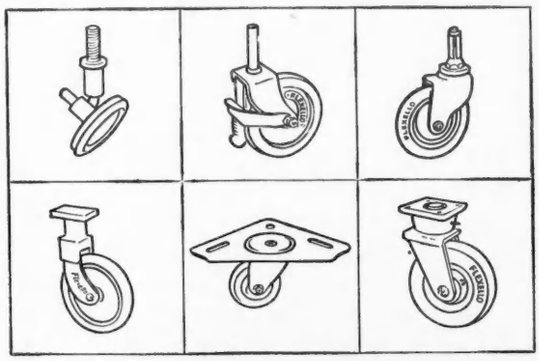

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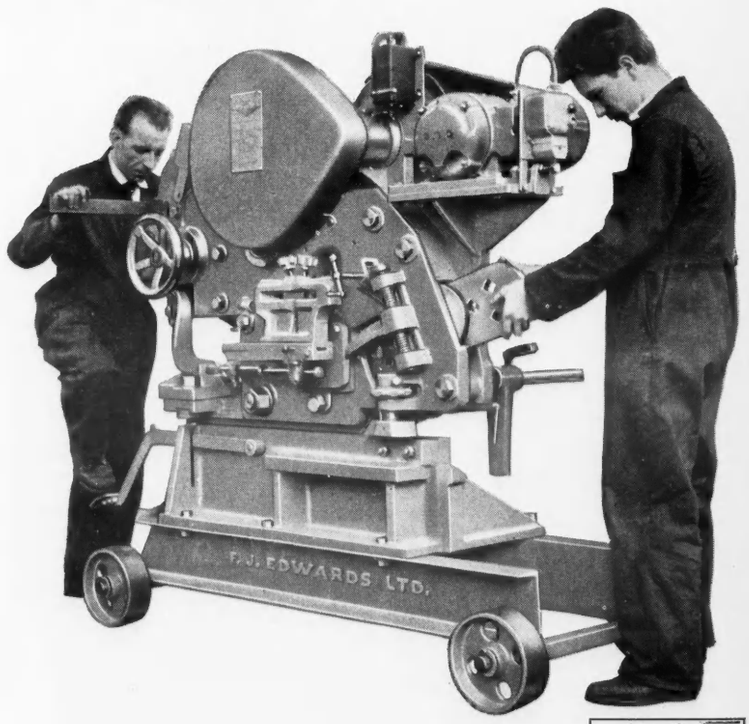

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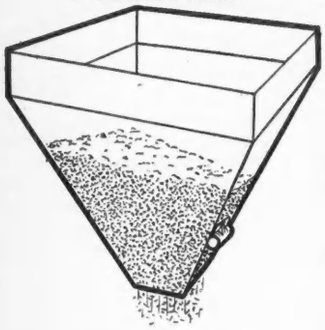

The installation of an external vibrator to a steel hopper.

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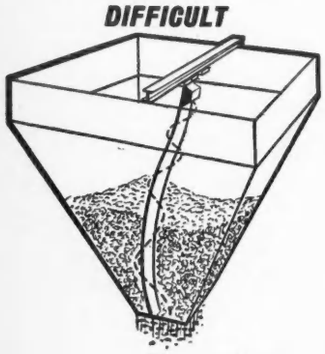

The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

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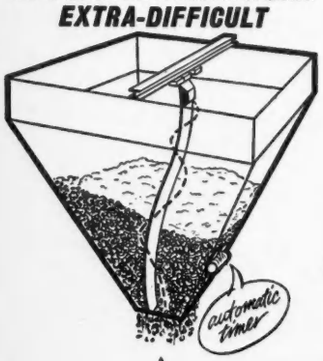

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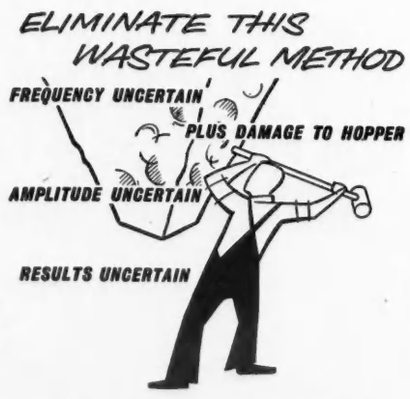

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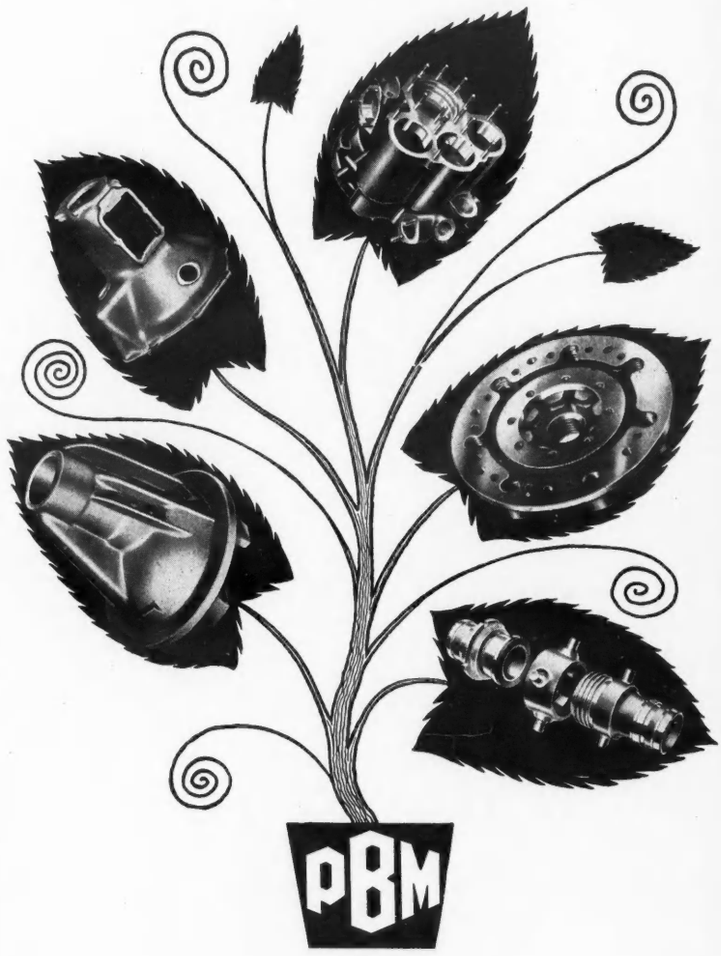

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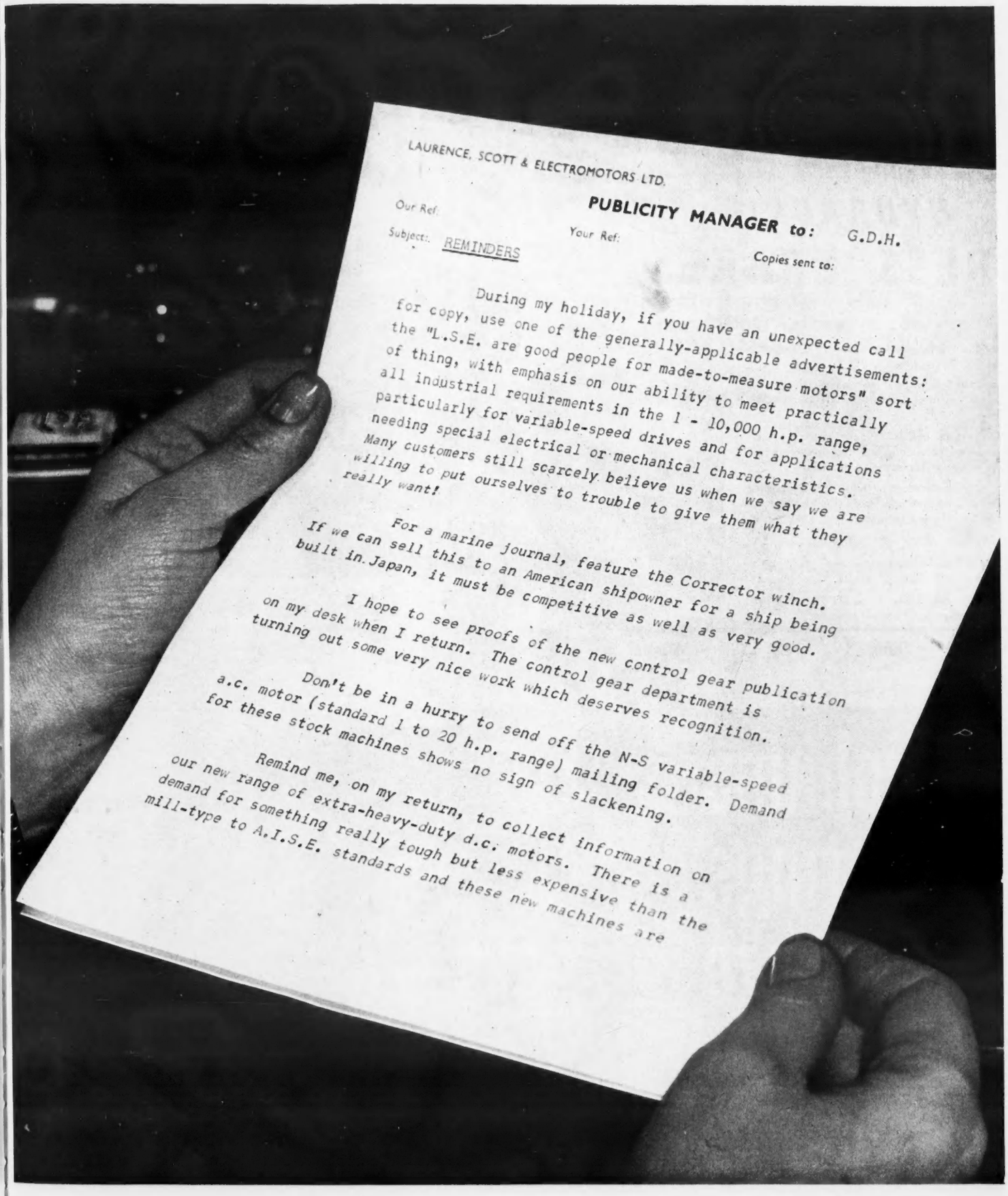
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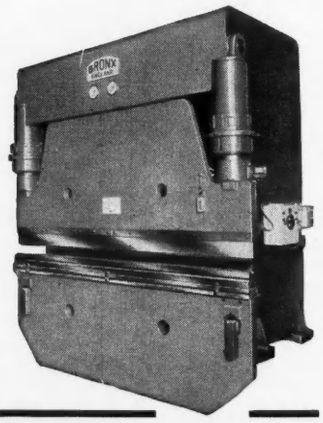

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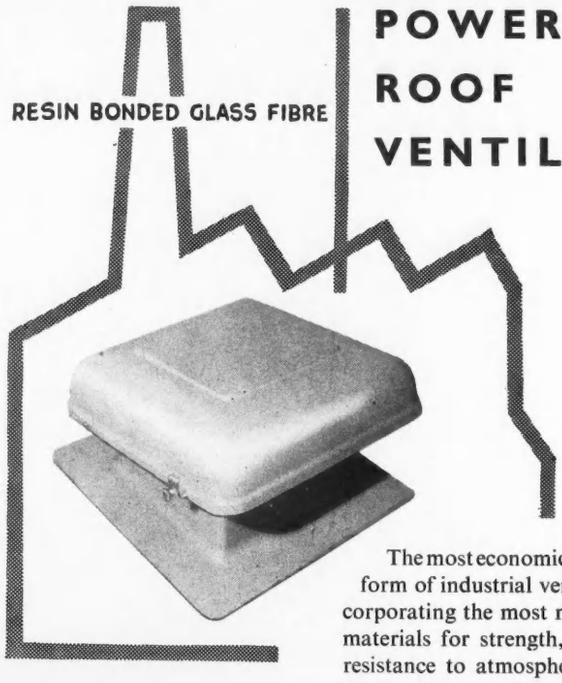

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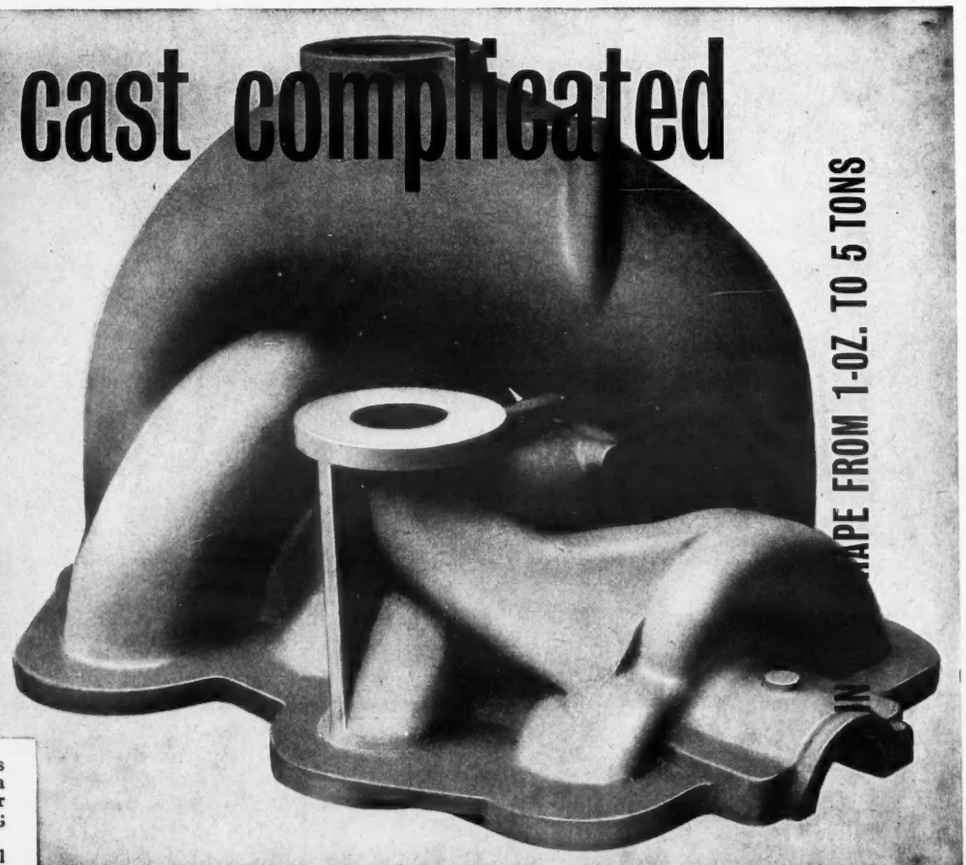

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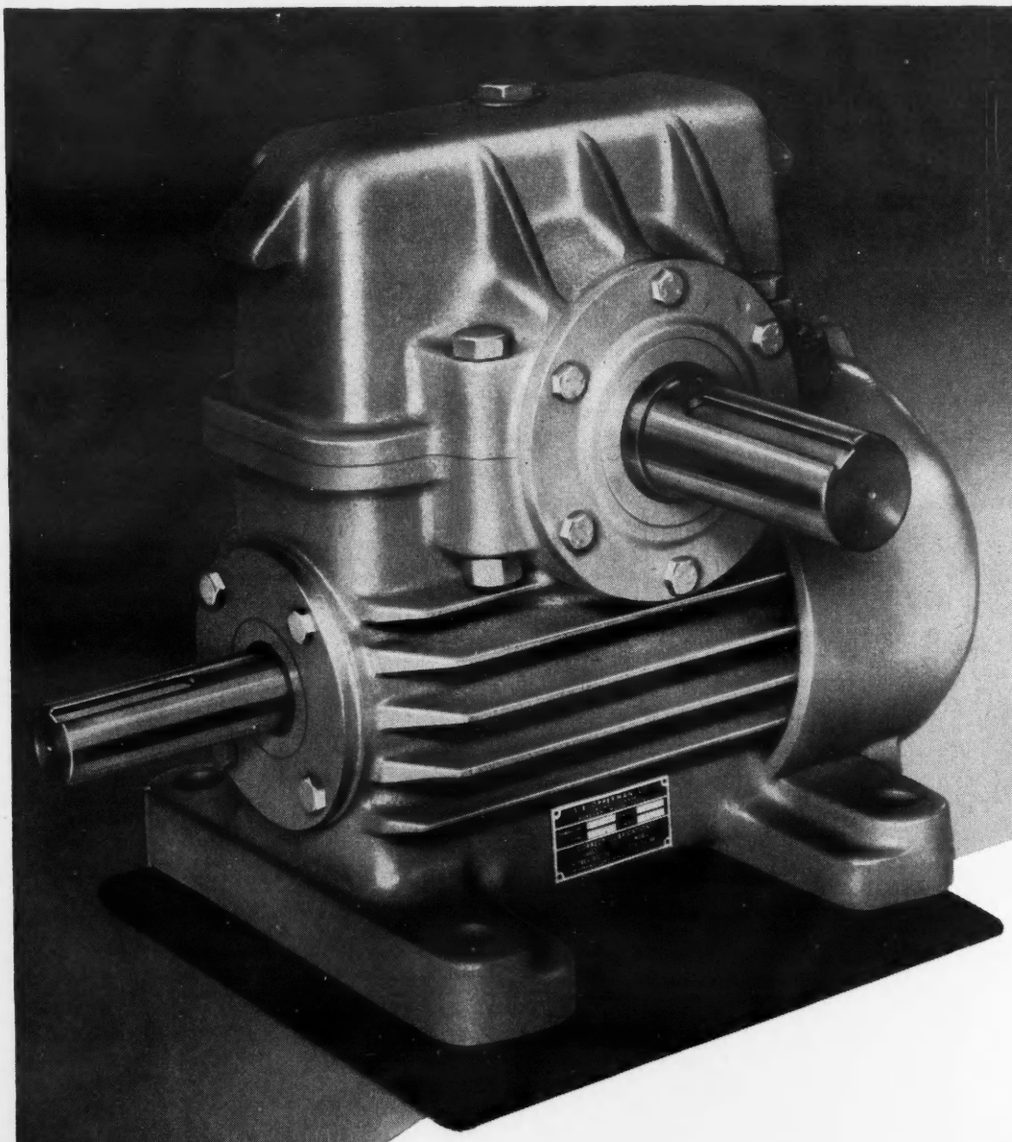

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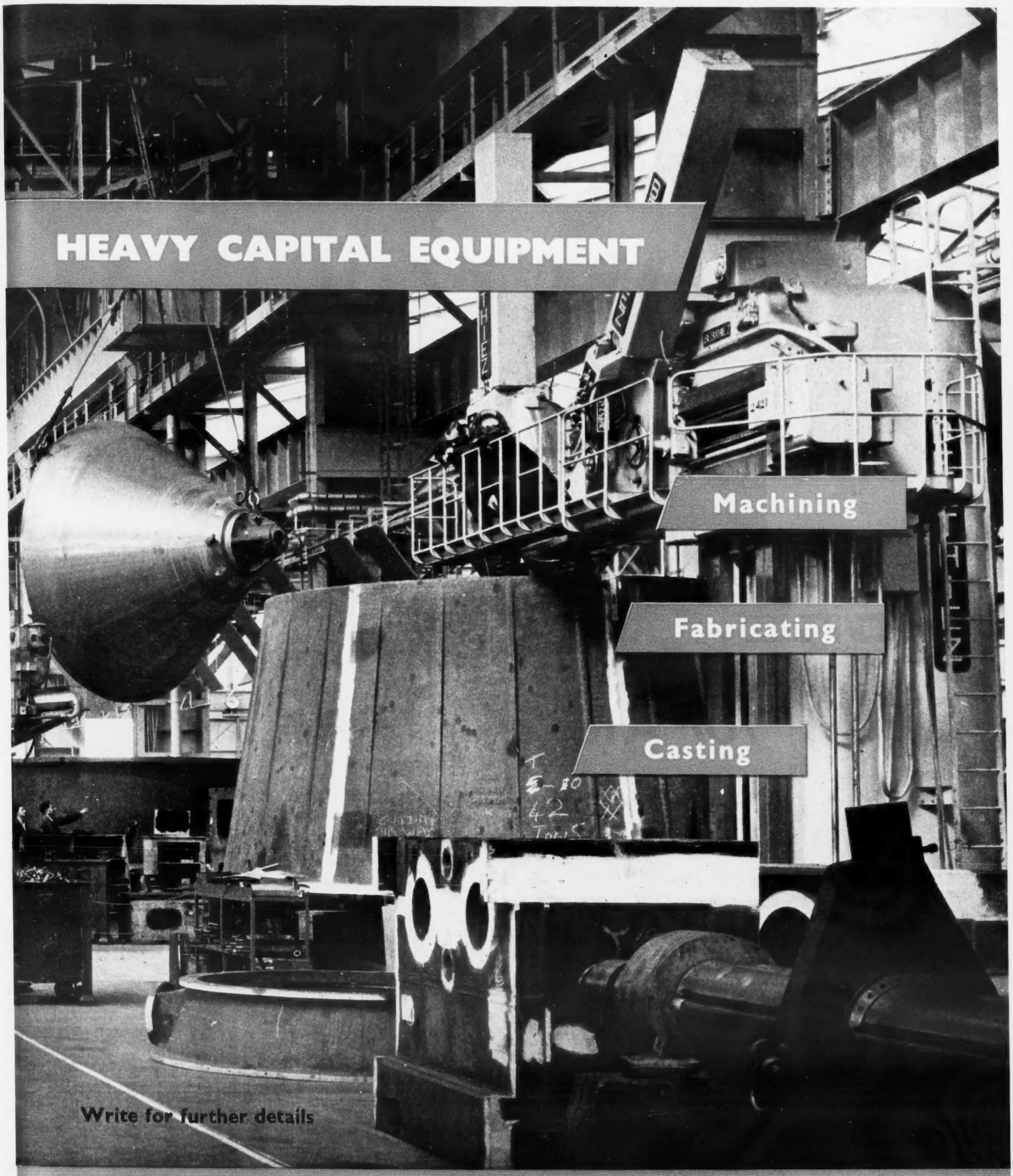

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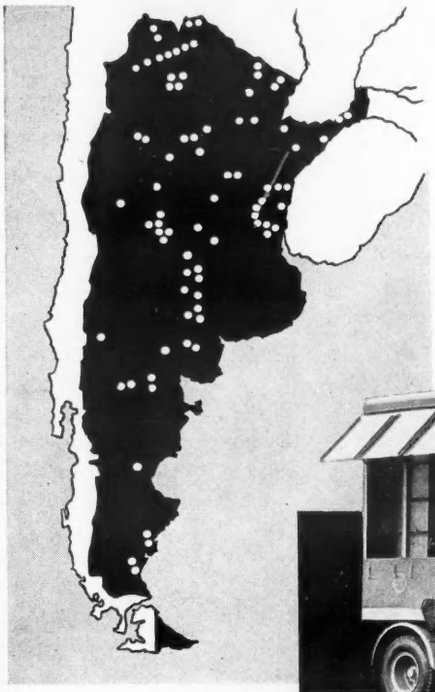

Map showing approximate locations of National generating sets in Argentina.

One of the four 500 kW transportable generating sets.

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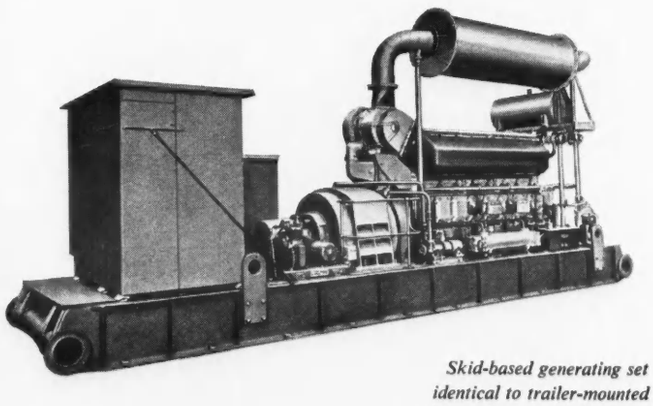

Skid-based generating set identical to trailer-mounted model to promote uniformity of operation and output.

A total of 115 National diesel generating sets aggregating over 25,000 kW are operating in Argentina, including eighty-three 110 kW and eleven 500 kW sets with standard engine baseplates.

Four further 500 kW transportable generating sets by National are now in Argentina to supplement the sixteen similar sets delivered during 1959. These trailer-mounted units are interchangeable with skid-based sets, to give standby or emergency power supply to scattered townships in the interior. Each set comprises a National R Series turbo-charged eight-cylinder engine developing 864 b.h.p. at 750 r.p.m., direct coupled to a Brush alternator complete with exciter, voltage regulator, switch-gear, etc.

National diesel engines are available from 80 to 2400 b.h.p., engines are also supplied for operation on heavy fuel oil, sewage and natural gas, and as dual fuel, gas or alternative fuel engines.

Please write for further information to:-

THE NATIONAL GAS AND OIL ENGINE CO. LTD., ASHTON-UNDER-LYNE, ENGLAND

Overseas Organisation: HAWKER SIDDELEY BRUSH INTERNATIONAL LTD., National Works, Ashton-under-Lyne, England.

A member of the Hawker Siddeley Group

NAT 79

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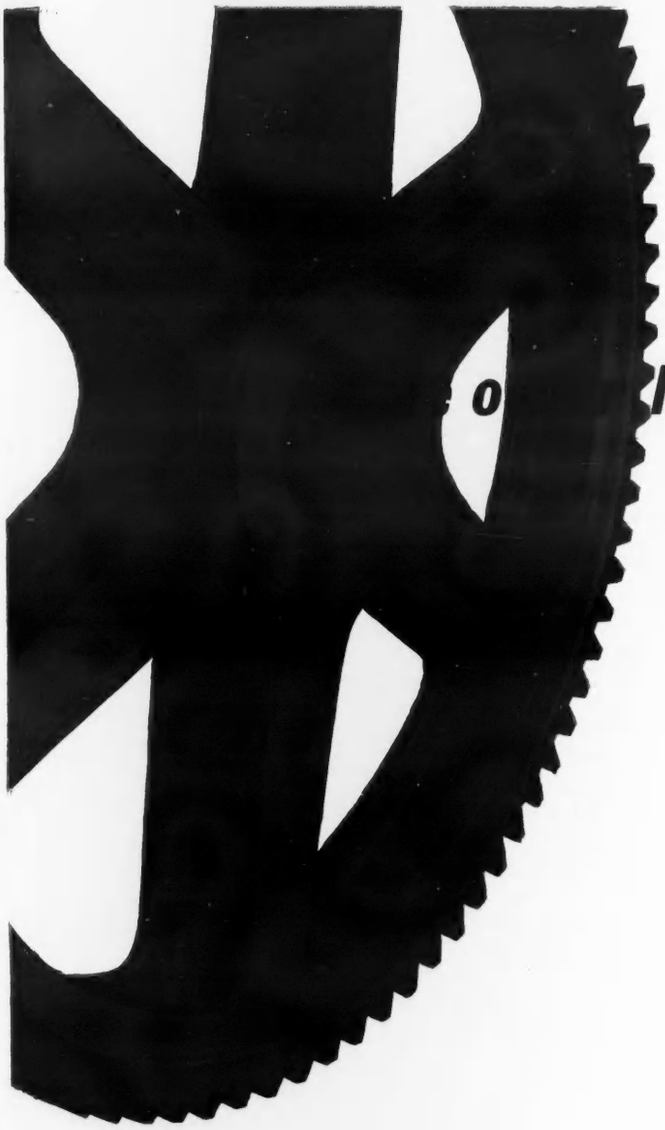

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AN INTRODUCTION TO

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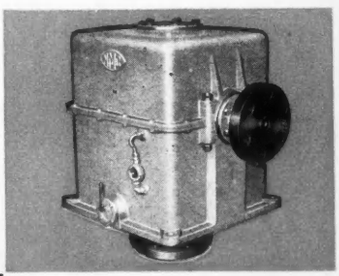
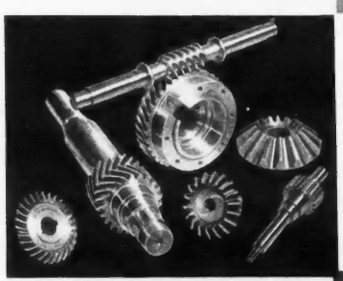
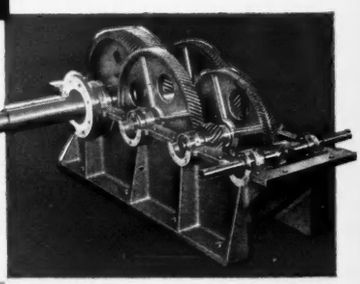
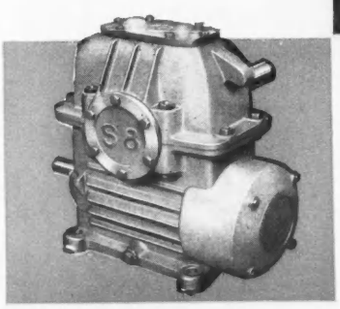




Various types of Machine Cut Gears

Triple Reduction Helical Unit





British Standard type Worm Gear

NMC

NORTHERN MANUFACTURING CO. LTD.

GEAR SPECIALISTS
GAINSBOROUGH • LINCOLNSHIRE
Telephone No. 2231 (8 lines) Telex 5641

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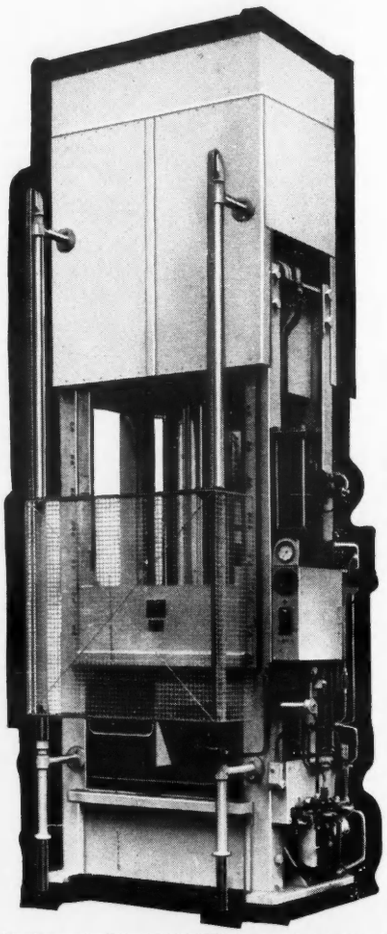

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Features of this BIPEL press are its large table area, ample daylight, long stroke ejector gear, and accuracy in operation. Special presses can be made to suit customer's requirements.

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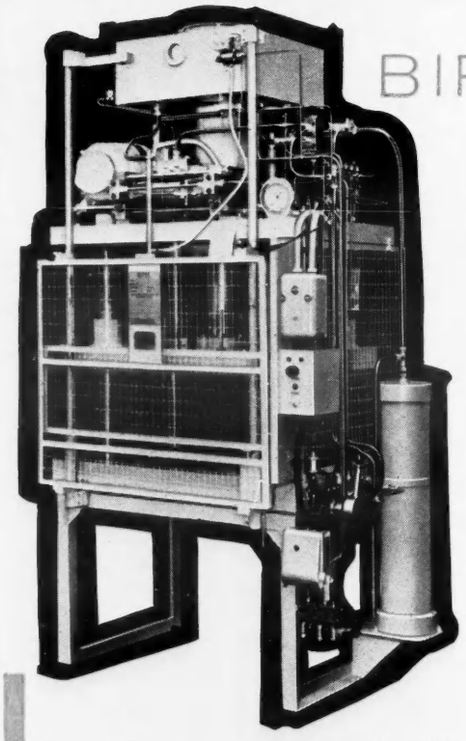

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This entirely new downstroking 30 ton BIPEL hydraulic flash clipping press has all the advantages of accurate semi-automatic operation. It is fast and safe to operate. Pressure range 10, 20 or 30 tons.

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Write for full details to **B.I.P. ENGINEERING LIMITED,** STREETLY WORKS, SUTTON COLDFIELD Telephone: Streetly 2411

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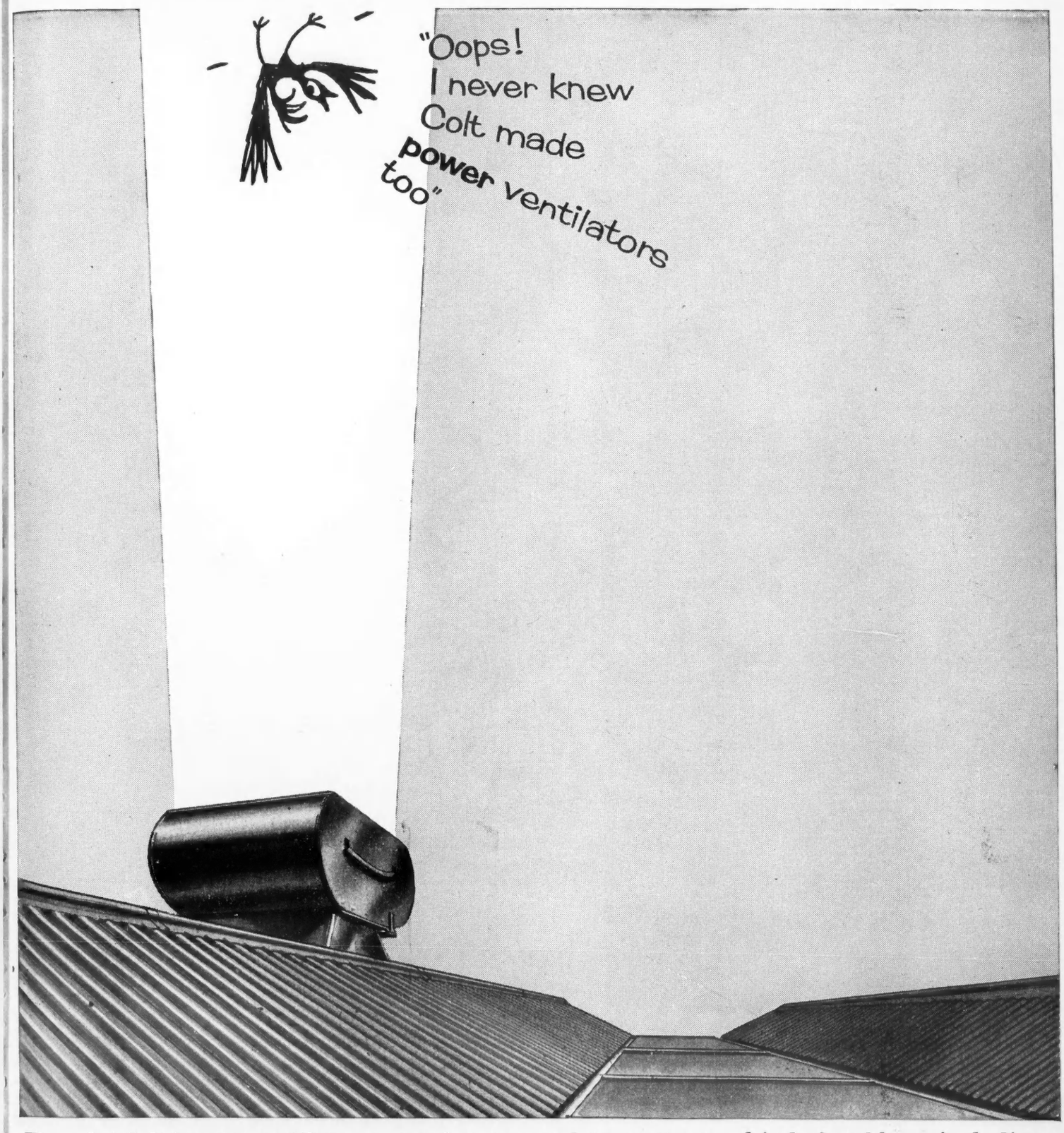

They do! Colt have a ventilator, natural or powered, to meet every kind of problem—including a range of high powered ventilators such as the Upward Discharge unit shown here. Let the Colt Ventilation Service advise you. Powered or natural, or a combination of both—the Colt engineer will tell you which system is best and most economical for you. Send for a manual to Dept. 37

COLT

The power behind natural ventilation and naturally behind powered ventilation too!

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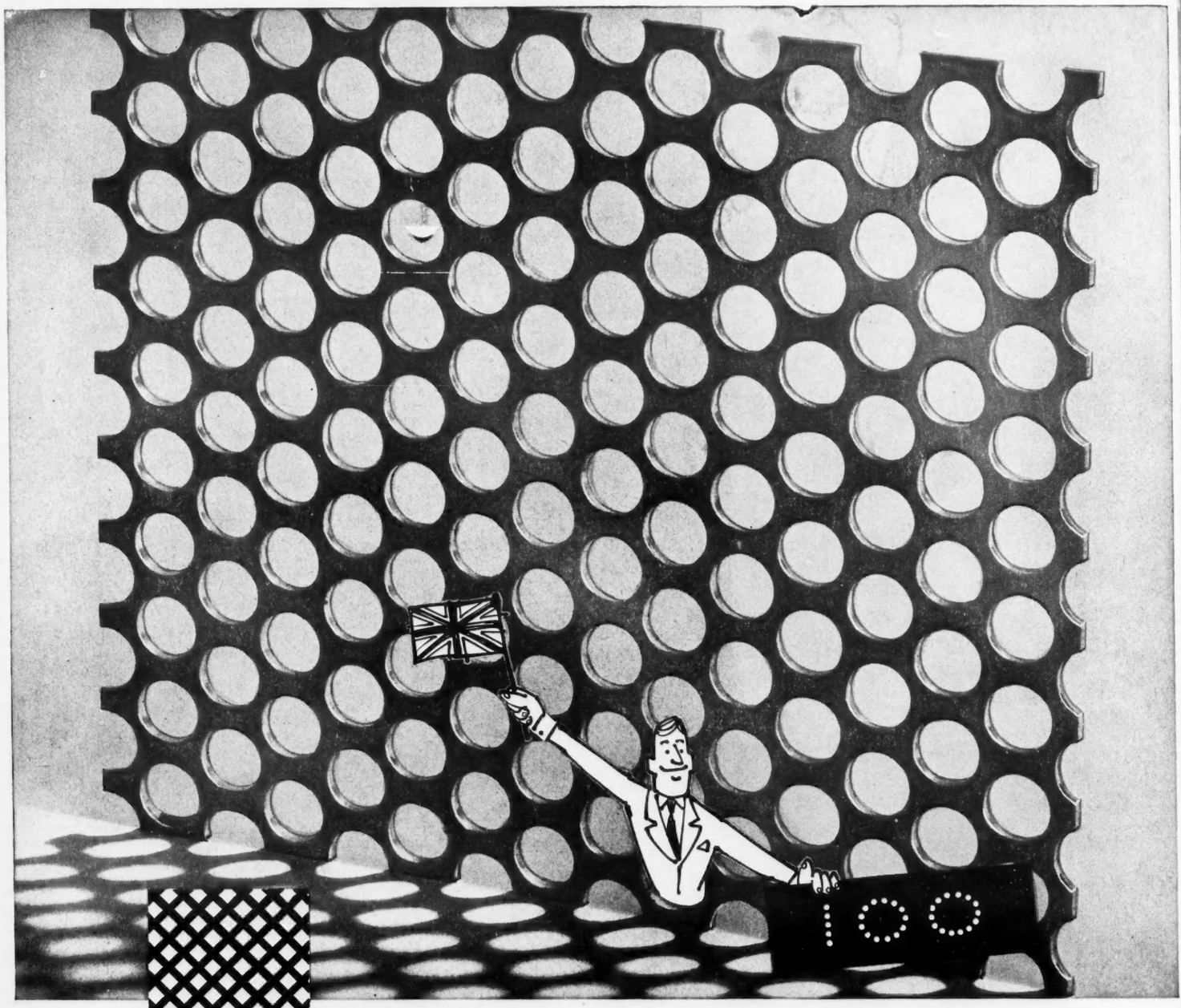

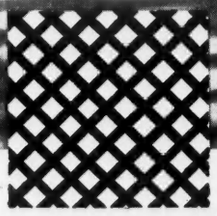

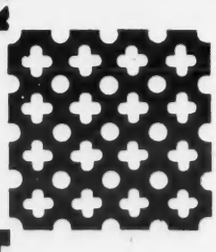

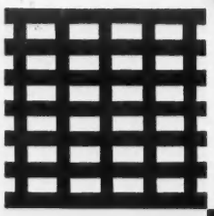

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FWS

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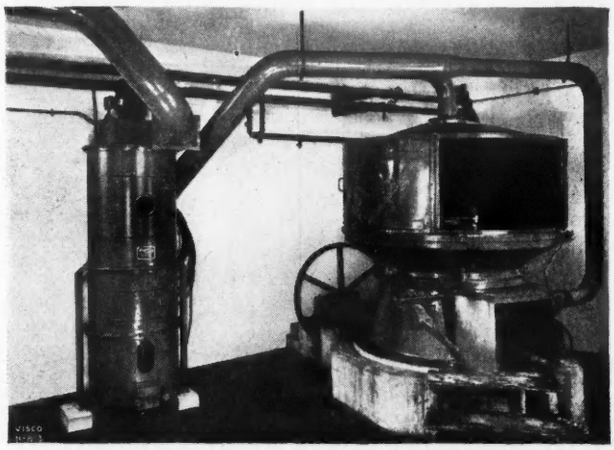

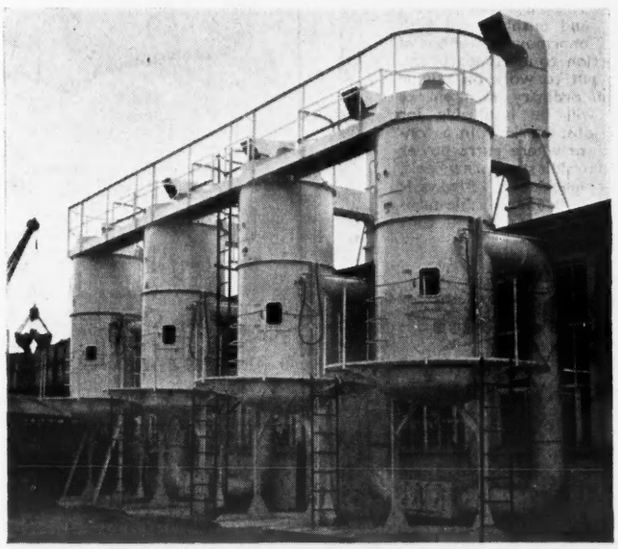

Wet or dry? If wet, and when it is simpler and advisable to dispose of "valueless" dust in a sludge form, the VISCO-HANDTE Dust Collector is the answer in many cases to this form of dust collection. It is manufactured and sold exclusively in the United Kingdom by VISCO. Enquiries are invited to THE VISCO ENGINEERING CO. LTD., Stafford Road, CROYDON, SURREY. CROydon 4181.

VISCO-HANDTE

Wet type Dust Collectors

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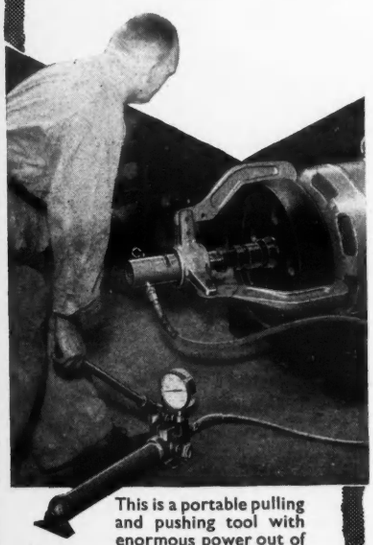
Always a busy tool in any works...



This is a portable pulling and pushing tool with enormous power out of all proportion to its compact size. It can be put to work on a wide variety of ordinary maintenance jobs. It will be invaluable for awkward jobs, working in a confined space or where extra power is required to shift stubborn wheels, pulleys or machinery. Always it will save labour and valuable man-hours. Models up to 100 tons capacity.

"LOADSTAR"

PORTABLE HYDRAULIC POWER TOOL

Range of 3 to 100 tons capacity

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Removal of pulleys, gears, bushes, etc., can be undertaken quickly and economically.

PRESSING
For all these jobs it is only a matter of minutes to secure the required "set-up."

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For assembly or wherever power is required for moving machinery, the "LOADSTAR" is invaluable.

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Attachments for bending tubing to B.S.1387 up to 2" diameter.

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Demonstrates the versatility of the "LOADSTAR" which can work in very restricted spaces.

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BOW STREET, BIRMINGHAM 1.
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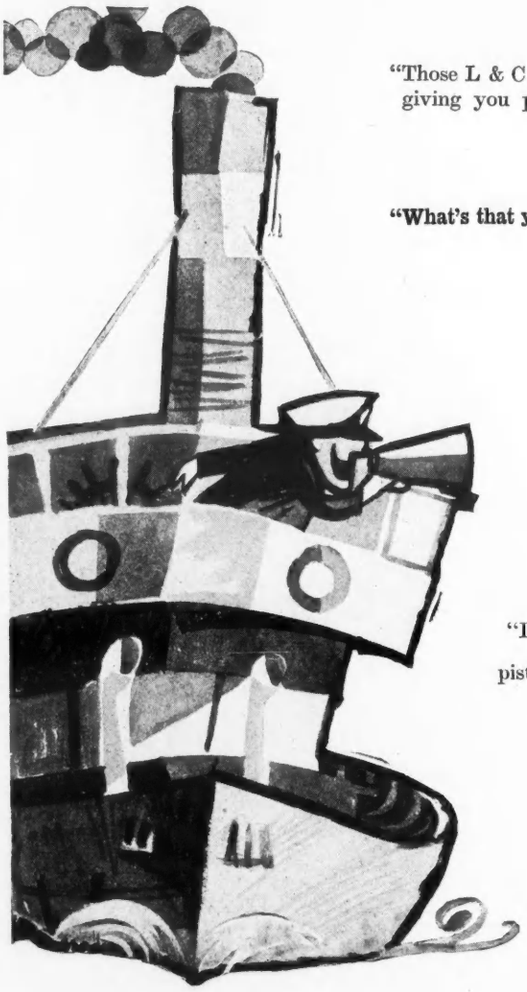

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"What's that you say?"

"I said, since you fitted L & C piston rings you've left us all standing"

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"Whatsamatter, you can't raise any more speed? Give you a tip—get your owners to fit L & C piston rings."

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The nylon faces, which are turned from a special grade of nylon rod, screw into a machined steel head, and can be fitted or replaced by hand in a few seconds. They are made with a shoulder for increased strength, and serrations to prevent loosening in use. This super quality nylon gives a firm but resilient blow that does not mar the work, is extremely durable, and will not crack nor chip. THOREX is the best "soft" hammer THOR has produced in 25 years, and Works and Production Managers, Buyers and Senior Staff are invited to write for a free test sample and further particulars.

A wide range of THOR Rawhide, Copper, Plastic and Rubber hammers is also available for factory use by toolmakers, metal-workers, mechanics, fitters, assemblers, etc.

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. . . in the end is what matters, for it is the cutting end of Stag Major steel which pays off. Not just a tip, but a good substantial piece of finest super high-speed steel, inseparably fuse-butt-welded to a high grade shank.

A complete tool, hardened and ready for use, for lathe, planer, shaper etc., at little more than the cost of redressing by forging a solid tool.

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Please send 'SUPERWELD' Booklet and Chart to:

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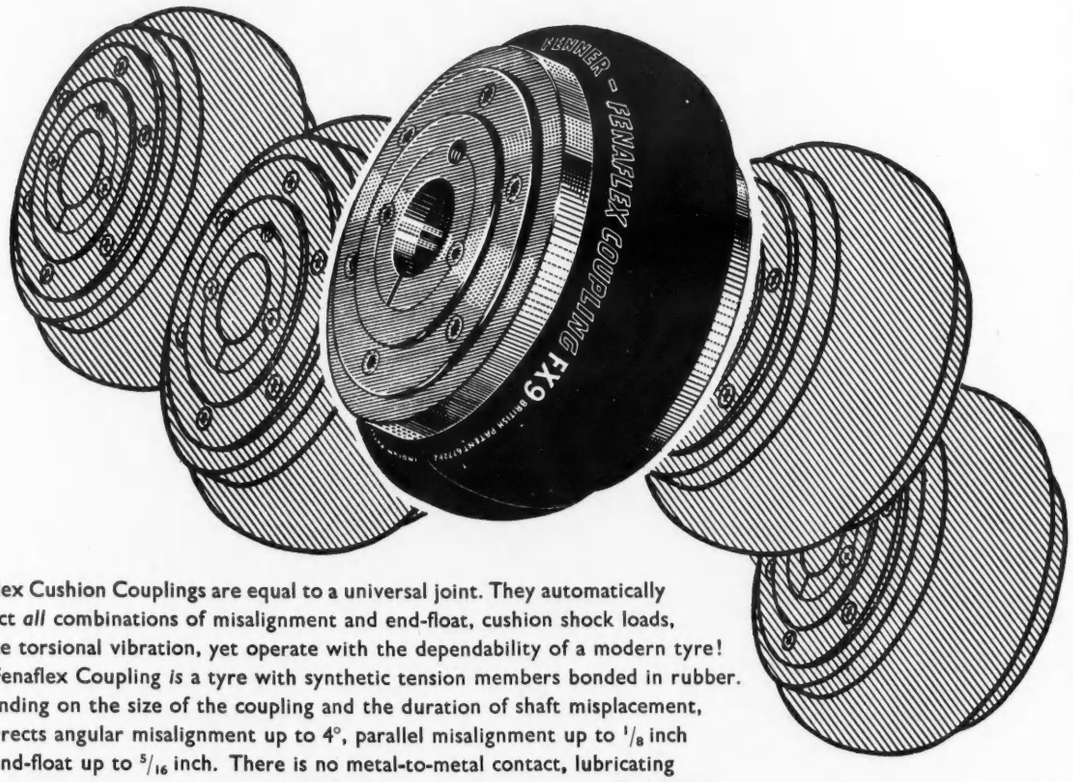
CUSHION COUPLINGS



THE RUBBER TYRE COUPLINGS WITH THE FOUR-WAY FLEX

Fenaflex Cushion Couplings are equal to a universal joint. They automatically correct *all* combinations of misalignment and end-float, cushion shock loads, reduce torsional vibration, yet operate with the dependability of a modern tyre! The Fenaflex Coupling *is* a tyre with synthetic tension members bonded in rubber. Depending on the size of the coupling and the duration of shaft misplacement, it corrects angular misalignment up to 4°, parallel misalignment up to $^{1}/_{8}$ inch and end-float up to $^{5}/_{16}$ inch. There is no metal-to-metal contact, lubricating is unnecessary and there are no protruding parts.

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Leaflet 353/18 will give you full technical information.

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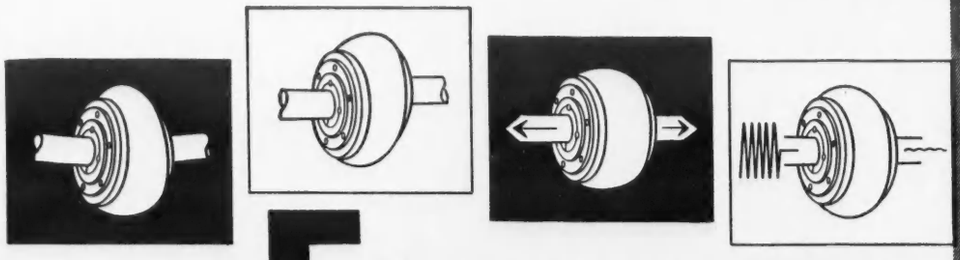

Fenaflex Couplings are obtainable from stock at all 19 Fenner branches and Fenner engineers will gladly demonstrate Fenaflex to you—telephone your nearest branch.

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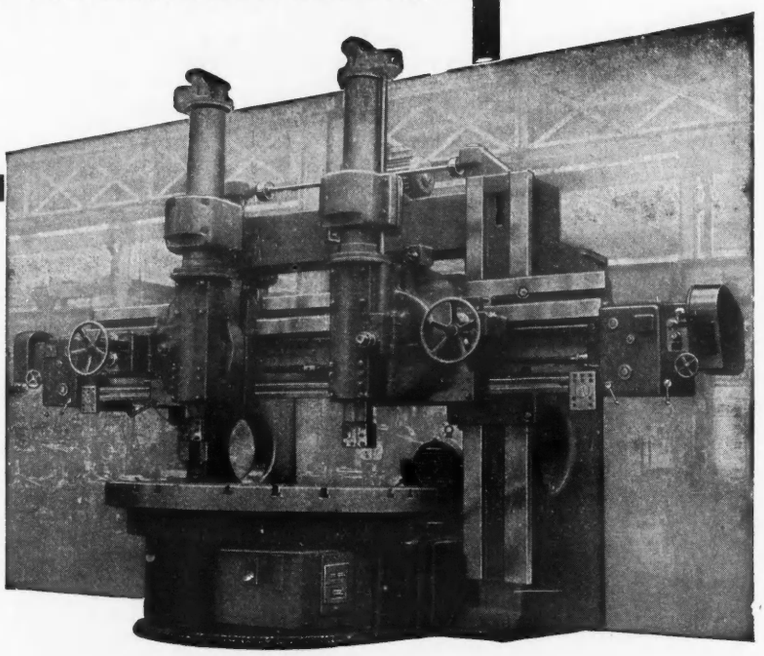

These machines are of heavy construction, each with a 30 h.p. constant-speed table driving motor and a twelve-speed gear box. Feed traverse to each saddle and its ram is by an independent variable-speed motor, and additional constant-speed motors are used for all quick traverse movements.
Duplicate control stations give complete pushbutton operation of the main motor and full selection of the ram and saddle movements, including change-over from feed to quick traverse and vice versa, the various engagements being made by magnetic clutch operation.

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CRAVEN MACHINE TOOLS

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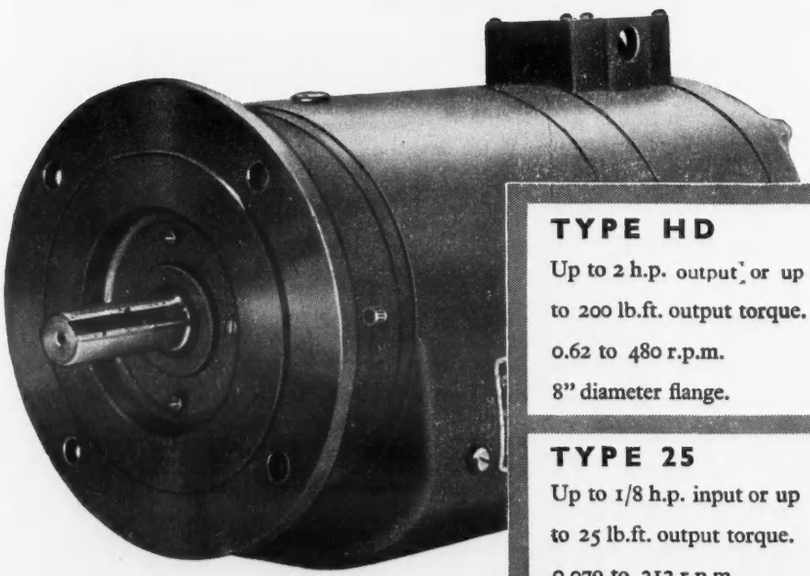
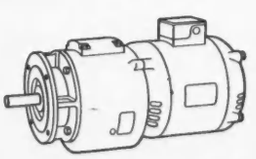
flange mounting geared motors

All NECO co-axial geared motors can be supplied with flange mounting instead of feet to enable the unit to be bolted accurately to your machine.

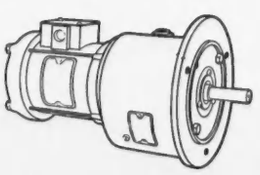
TYPE DS
Up to 1/2 h.p. input or up to 100 lb.ft. output torque. 0.5 to 475 r.p.m. 8" diameter flange. Removable feet can be supplied with this unit.



TYPE HD
Up to 2 h.p. output or up to 200 lb.ft. output torque. 0.62 to 480 r.p.m. 8" diameter flange.



TYPE 25
Up to 1/8 h.p. input or up to 25 lb.ft. output torque. 0.079 to 312 r.p.m. 8" diameter flange.



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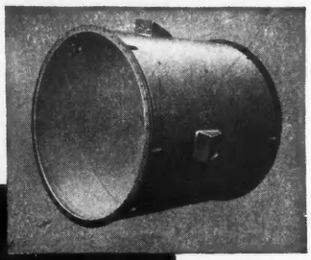
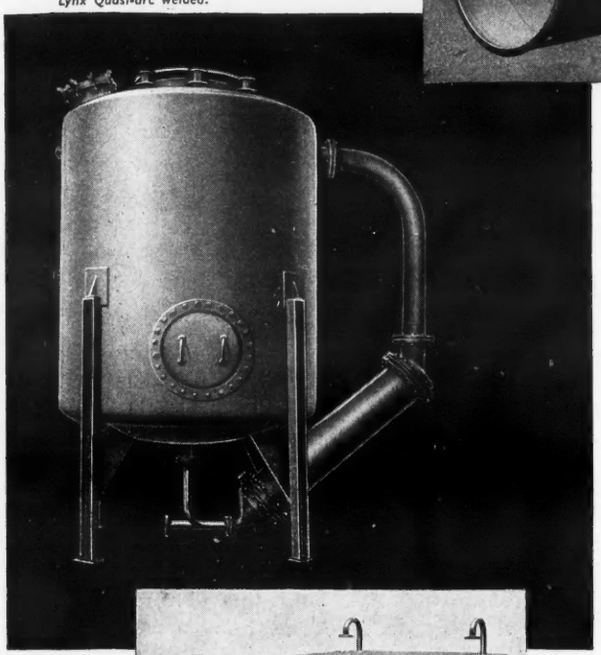


Stainless steel vessel with mild steel jacket

1,000 gall. kettle in ¼" copper. Lynx Quasi-arc welded.



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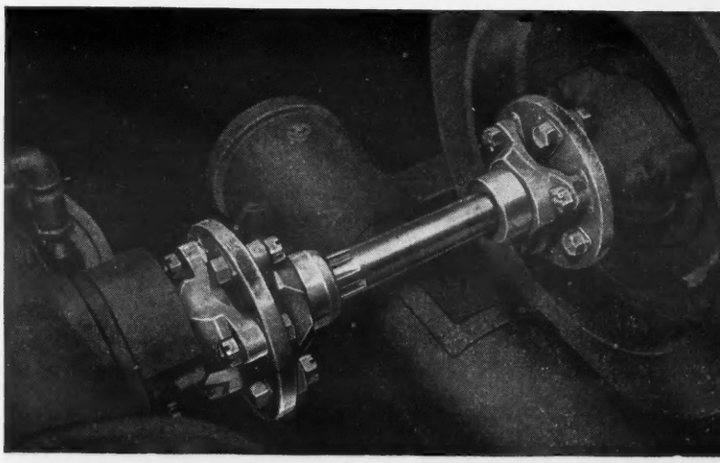
through the medium of
FLEXIBLE FABRIC COUPLING DISC



★ **Are easily assembled.**
★ **Give extreme torsional flexibility.**
★ **Absorb irregularities in load variations.**
★ **Axial and parallel misalignments are corrected.**

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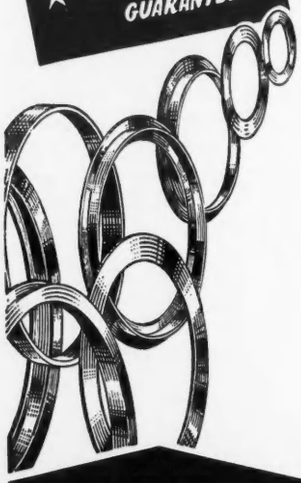

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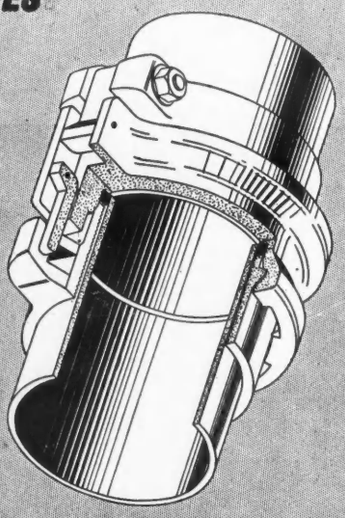
ALL PLAIN-END PIPES
COUPLED WITHOUT PREVIOUS END PREPARATION

WILSON
SEAMARK

PIPE COUPLINGS



No preparation is required for the ends of the pipes which may be Plain, Threaded, Grooved for other types of Couplings, or Bevelled for Welding, etc. The Coupling can be used on Bends, Tees or Crosses, and can be inserted into an existing pipeline without moving the pipes laterally. The WILSON-SEAMARK COUPLING has many and varied applications and has given the Engineer a new and useful pipe-laying tool. Please write for Wilson-Seamark Catalogue.

WILSON PIPE FITTINGS LIMITED
Irvine Ayrshire
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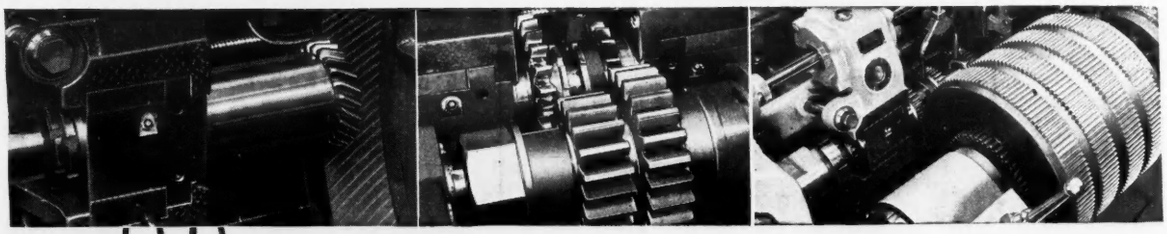

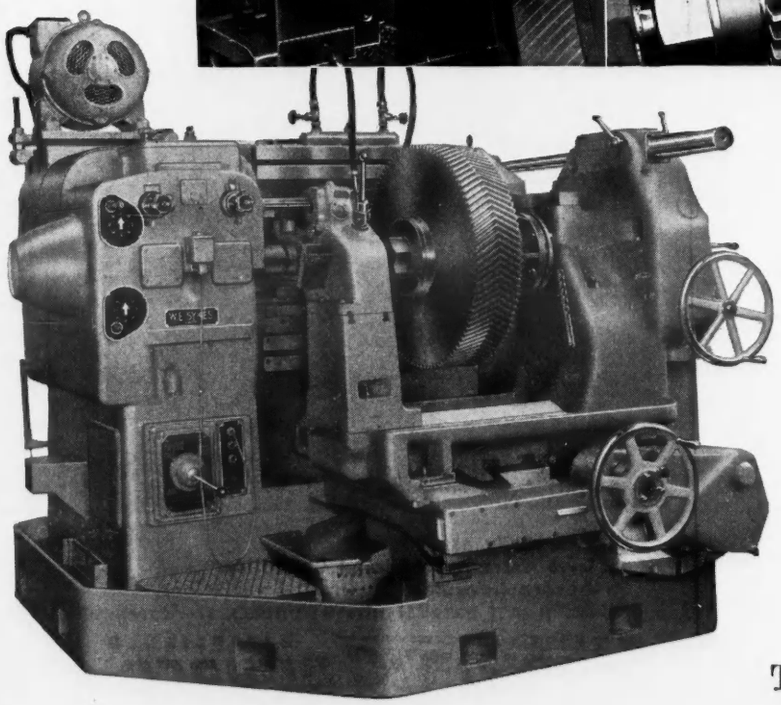

For peak gear production

Combining high precision with an exceptional production capacity the Model 3C horizontal gear generator is suitable for a wide range of applications.

The multi-cutter principle permits the simultaneous generation of up to 16 or more spur or helical gears, both helices of a double helical gear or two elements of a cluster gear.

Internal spur or helical gears, splines or serrations can be generated by the use of simple attachments.

Capacity: 40 in. blank diameter, 36–2½DP, 10 in. face width.

Talk to SYKES about gear production

W. E. SYKES LIMITED · STAINES · MIDDLESEX · ENGLAND and associated companies: Sykes Tool Corporation Ltd., Georgetown, Ontario, Canada
Sykes Machine & Gear Corporation, Newark, NJ, USA. W. E. Sykes Ltd., Mascot, Sydney, NSW, Australia.

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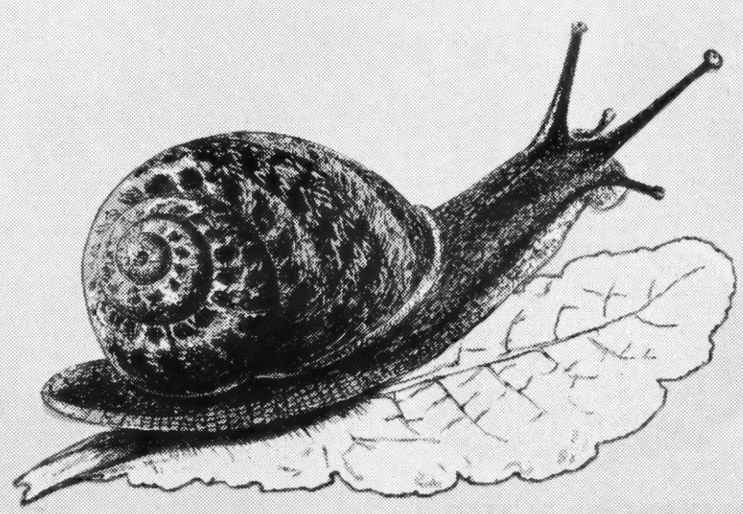

MADE TO MEASURE

The snail, most thoughtfully, goes to some pains to reconcile his own needs with those of the conchologist.

● As home and protection, his shell must be tough, portable, and very much made to measure. At the same time, it must have just those qualities which—in due course—will delight the collector.

● Sheet steel from the City of Steel follows no less closely its intended purpose. Each order is treated as a separate assignment so that you, the manufacturer, get the particular kind of steel your product needs.

● Steel, in fact, made to measure—to your exact requirements.

THE STEEL COMPANY OF WALES LIMITED

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MANAGING DIRECTOR DAVID C.Y. HIGGS, A.M.I.E.E.

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DRIP-PROOF MOTORS

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CLASS 'E' INSULATION

OTHER MOTORS up to 1000 H.P. and GENERATORS up to 700 kVA

BELFAST BRISTOL CARDIFF DUBLIN DUNDEE GLASGOW HULL LEEDS LIVERPOOL LONDON MANCHESTER NEWCASTLE PETERBOROUGH SHEFFIELD WOLVERHAMPTON

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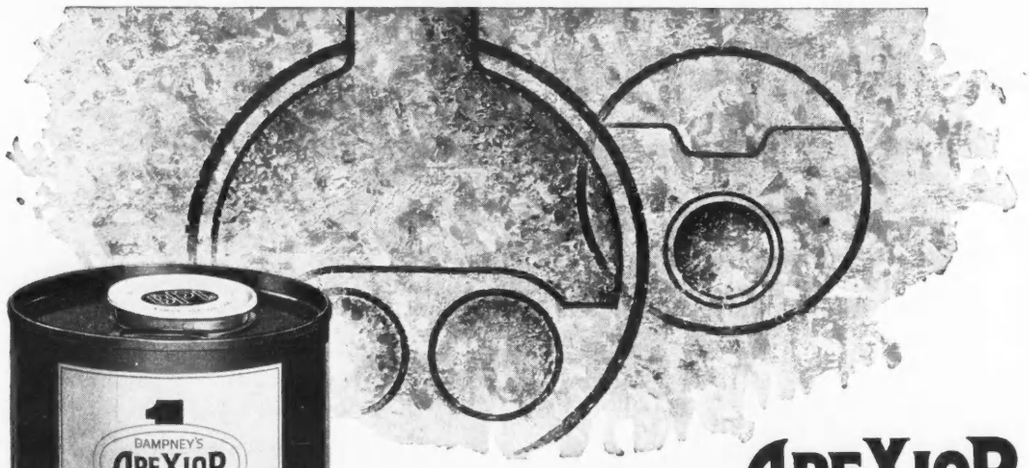
Between you and Boiler Corrosion . . .



DAMPNEY'S
APEXIOR
REGISTERED
COMPOUND
A PROTECTIVE COATING FOR THE INTERIOR SURFACES OF ALL TYPES OF STEAM PLANT, INCLUDING BOILERS ECONOMISERS, CALORIFIERS AND STEAM TURBINES. ALSO FOR HOT WATER TANKS ABOVE 170° F.
MANUFACTURED ONLY BY
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An impenetrable shield of APEXIOR REGISTERED No. 1

On guard, and constantly ready to fight against corrosion in boilers or steam raising plant is Apexior No. 1.

Applied as a thin film to surfaces which encounter water or steam temperatures between 170°—1000°F., Apexior No. 1 is an effective, low cost protection for expensive boiler plant. It cuts corrosion to an absolute minimum; reduces scale formation. Any scale which forms can be easily and speedily removed without danger of damage to plant as it is non-adherent.

Other advantages come with Apexior No. 1: heat transmission is improved; and since Apexior is an inert coating, feed water is left completely free from discolouration or contamination. Keep step with industry to-day—be boiler wise and Apexiorise.

For full information on all aspects of Apexior No. 1 write for Booklet "Preventing Boiler Corrosion".

BPL/A48

BRITISH PAINTS LIMITED Apexior Division

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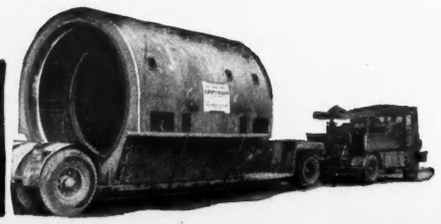
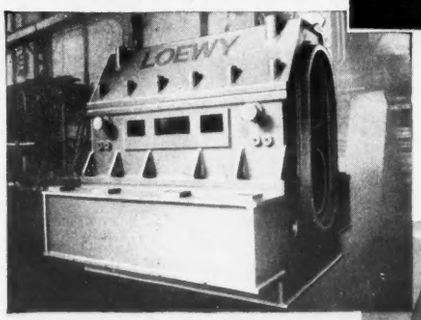
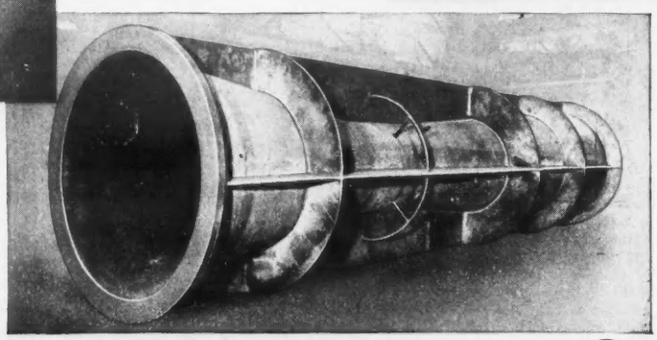
Heavy Welded Fabrications





For the ultimate in Welded Fabrications consult Empyrium, pioneers in this field.



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Telegrams : Empyrweld Birmingham

Transformer and Switchgear Tanks; Storage Tanks for Petrol, Oil and Water; Autoclaves; Chemical Plant of all descriptions; Bedplates; Machine Tool and Press Frames; Gas Works Plant; Hoppers, Condensers, Gear Guards, Blast Mains, Air Receivers and Pressure Vessels of all types.

Empyrium fabricate for all industries to ASME and Lloyd's specification. Also to the exacting requirements of the Petroleum and Oil Companies. Full testing facilities, including X-Ray.

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DELLBURN WORKS MOTHERWELL · SCOTLAND
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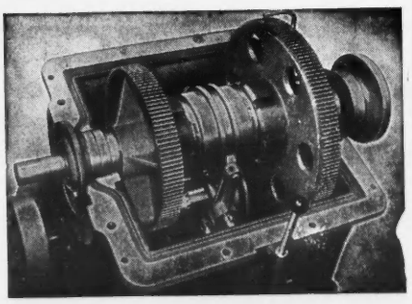
Powerful, Positive, Safe . . .



TAYLOR
Multiple Disc CLUTCHES

Resiliency, sensitivity, ease of control and the ability to perform continuous heavy duty without frequent adjustment, make Taylor Multiple Disc Clutches a popular choice for machine tool, plant, civil and heavy engineering. Such characteristics are ensured by:— Heat treatment and total enclosure of all operating parts; positive locking; single point adjustment and precision manufacture on modern plant. A Taylor Clutch is a self-contained unit, easily assembled, quickly fitted and produced to perform many years of strenuous work.

The illustration shows a typical application. The Reid Gear Co., Ltd., required a powerful, sensitive and completely trustworthy clutch unit for their two-speed reduction gear, to transmit the enormous effort applied in actuating the emergency sluice gate on a Scottish Hydro-Electric Project. The features mentioned above qualify Taylor Clutches to satisfy such exacting demands because they constitute the very ingredients of strength and reliability—the choice was a Taylor Multiple Disc Clutch.

TAYLOR INDUSTRIAL CLUTCHES
TROWS UPPER WORKS · CASTLETON · LANCS.

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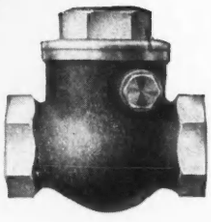
Peglers
CHECK VALVES

HIGH QUALITY / LOW PRICE

Designed for working pressures up to 150 lb. p.s.i., Peglers gunmetal check valves are available in a wide range of types and sizes. All are fully tested hydraulically.
Such outstanding quality at a low price is the result of a long tradition of careful craftsmanship allied to modern production techniques.

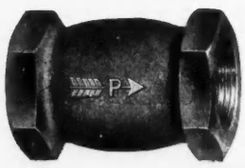


1050A HORIZONTAL or VERTICAL CHECK VALVE

Swinging type. Sizes ⅜"-2"— Female ends tapped BSPT (taper) BS21 2½"-3"— Female ends tapped BSPT (par) BS84.

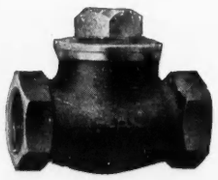
1043 FLANGED HORIZONTAL CHECK VALVE

Lifting type. Prong-type metal valves. Sizes ¼"-2". Flanged to BST 'E' as standard or BST 'F' on request.



1060 VERTICAL CHECK VALVE

Sizes ¼"-2"— Female ends tapped BSPT (taper) BS21. 2½" and 3" Female ends tapped BSPT (par) BS84.



1039 HORIZONTAL CHECK VALVE

Lifting type. Prong-type metal valve. Sizes ¼"-2" —Female ends tapped BSPT (taper) BS21. 2½"-4"— Female ends tapped BSPT (par) BS84.

Peglers Limited
The name is the guarantee

Worth Noting
Peglers for all gunmetal valves and cocks on air, water, oil and steam services. Write for catalogue.

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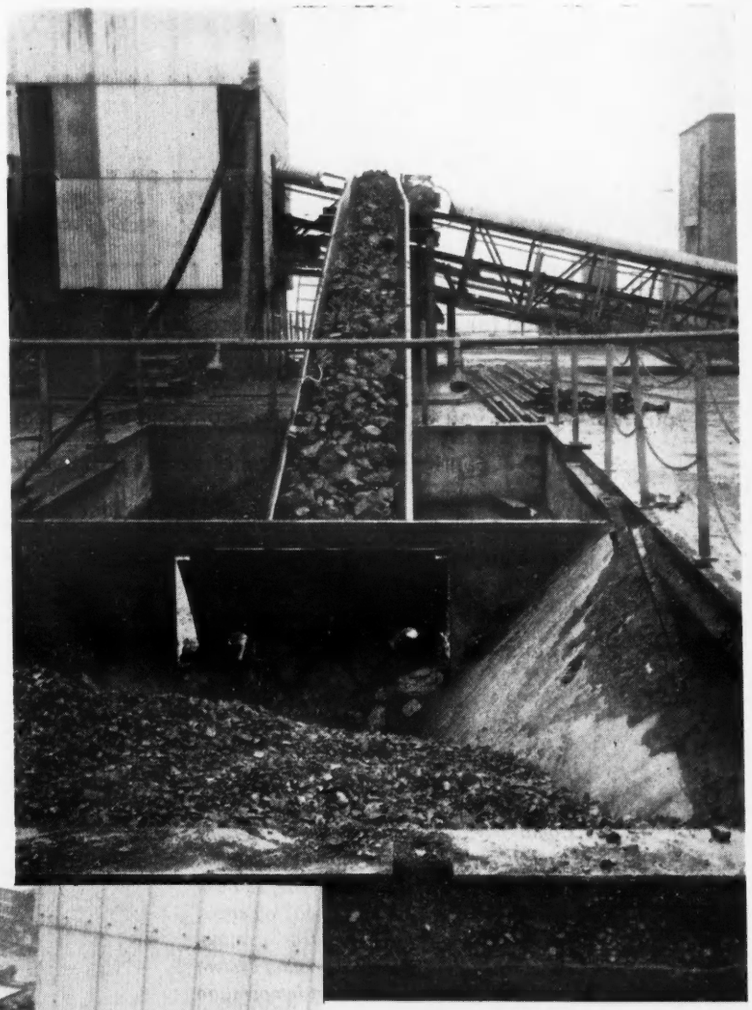
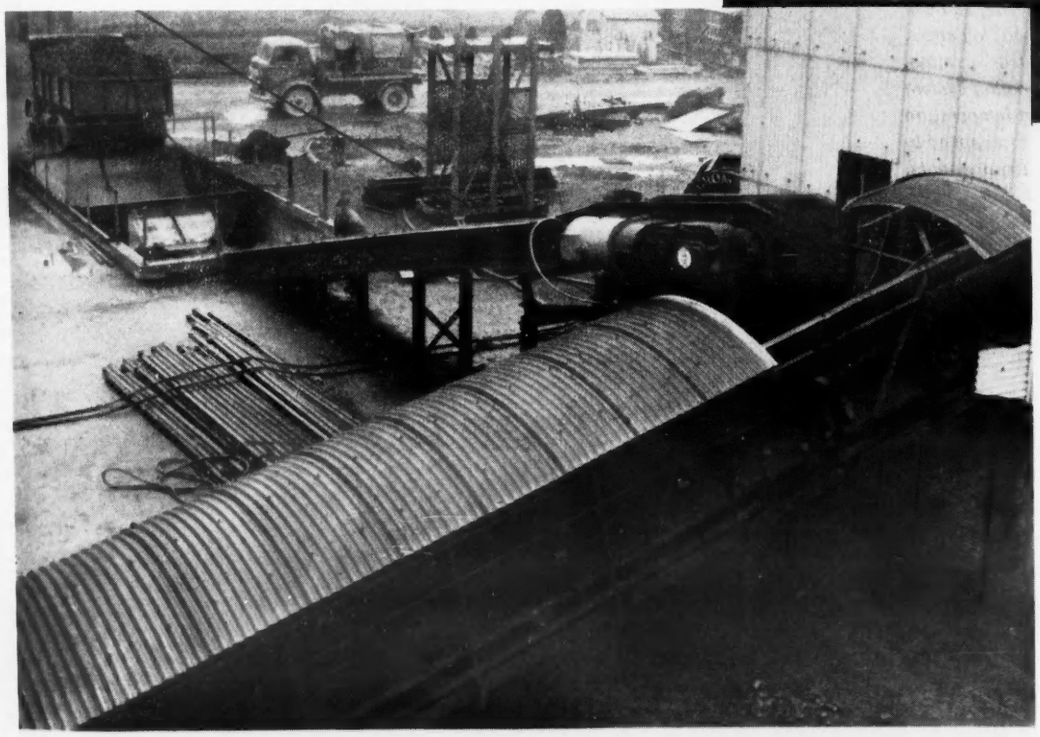
A Handling Problem SOLVED!





Photographs by courtesy of the National Coal Board.

Meco

Scraper Chain Conveyors are solving the problem of unscreened stock coal at a number of Midland Collieries. Coal is brought from the stock ground by lorries and tipped into a sunken hopper from which it is taken to the screens by a MECO Chain Conveyor which delivers to a Belt Conveyor already handling current production.

THE MINING ENGINEERING CO. LTD.

MECO WORKS, WORCESTER.

Telephone : WORCESTER 22291 (7 lines) Telegrams : MECO, WORCESTER

London Office: 50 Pall Mall, London, S.W.1.
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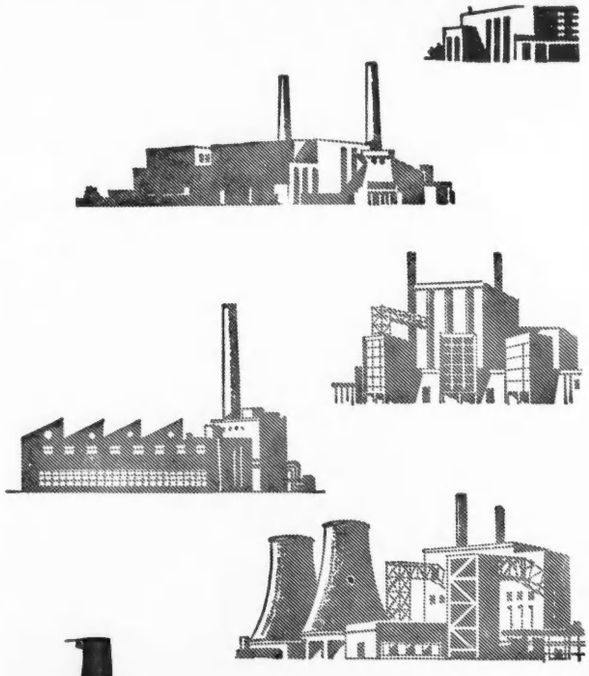
Power on the spot

Designed for modern industry, Mercedes-Benz Diesel Power Units bring you power on the spot—where you want it, when you want it—reliable, economic power that can be used in all branches of industry for countless applications.

The engines range from 17 to 71 h.p. and provide a source of power for pumps, lifts, drills, excavators, conveyor belts—in sugar refineries, saw mills, brick works, on building sites—anywhere!



Completely self-contained, Mercedes-Benz Diesel Power Units are built for reliability, easy-handling, simple maintenance, and can be run at the lowest possible operating costs. They have full instrumentation, weather-proof cowlings, a cooling system sufficient for 50°C ambient temperature and the output couplings can be supplied to suit users' requirements.

MERCEDES-BENZ

DIESEL POWER UNITS

Illustrated literature and information available from :

MERCEDES-BENZ (Gt. BRITAIN) LTD | INDUSTRIAL DIESEL ENGINE DIVISION, GREAT WEST ROAD, BRENTFORD, MIDDLESEX. Telephone : ISLeworth 5341

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CROFTS EXPRESS

MONDAY JULY 4th 1960

CROFTS BIRMINGHAM DISTRIBUTION CENTRE NOW OPEN!

BIG NEWS in Birmingham today is the opening by Crofts (Engineers) Limited of Bradford of a completely new showroom and distribution centre for their power transmission products at 253–255 Great Lister Street ('Phone ASTon Cross 4471/2).

Crofts anticipate great interest in this progressive development designed to give their customers the advantage of local stocks, and look forward to meeting old friends made during their 24 years in Birmingham as well as new ones.

Crofts impressive new distribution centre, stores and showroom for the Birmingham area at the junction of Great Lister Street and Windsor Street.

MR. A. L. DUCKERING

THE NEW premises are under the control of Mr. A. L. Duckering, Birmingham Area Sales Manager, who has transferred from Crofts previous Birmingham office at Daimler House, Paradise Street. Interviewed this morning, Mr. Duckering confirmed that he will have a complete technical staff available "to provide on-the-spot help and advice".

A. L. DUCKERING

NEW STOCK SERVICE

Off-the-shelf on the spot

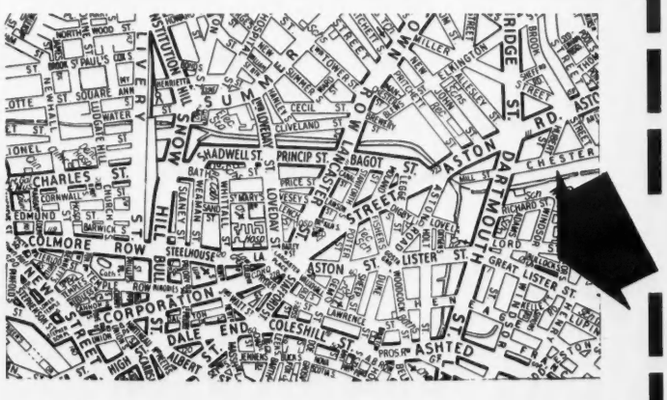
LOCAL ENGINEERS will applaud Crofts of Bradford for the new stock delivery service they now offer in the Birmingham area. Superior service is Crofts' announced aim and to ensure this, the following large selection of power transmission equipment will be held in stock.

Universal Worm Reduction Gears, Flexible and Rigid Couplings, Shaft-Mounted Gear Units, Collars and Plummer Blocks, 'Radiation' Worm Gears, Variable-Speed Pulleys, Slide Rails and Base Plates, V-Rope Pulleys and Drives, Timing Belt Drives, Machine Cut Gears, Taper Flushbushes.

STOP PRESS

Crofts Birmingham Manager, A. L. Duckering announced later today extension of worm gear stocks for new office. Crofts new universal mounting "Par-O-Mount" range will now be represented.

THE ROAD TO BETTER SERVICE!



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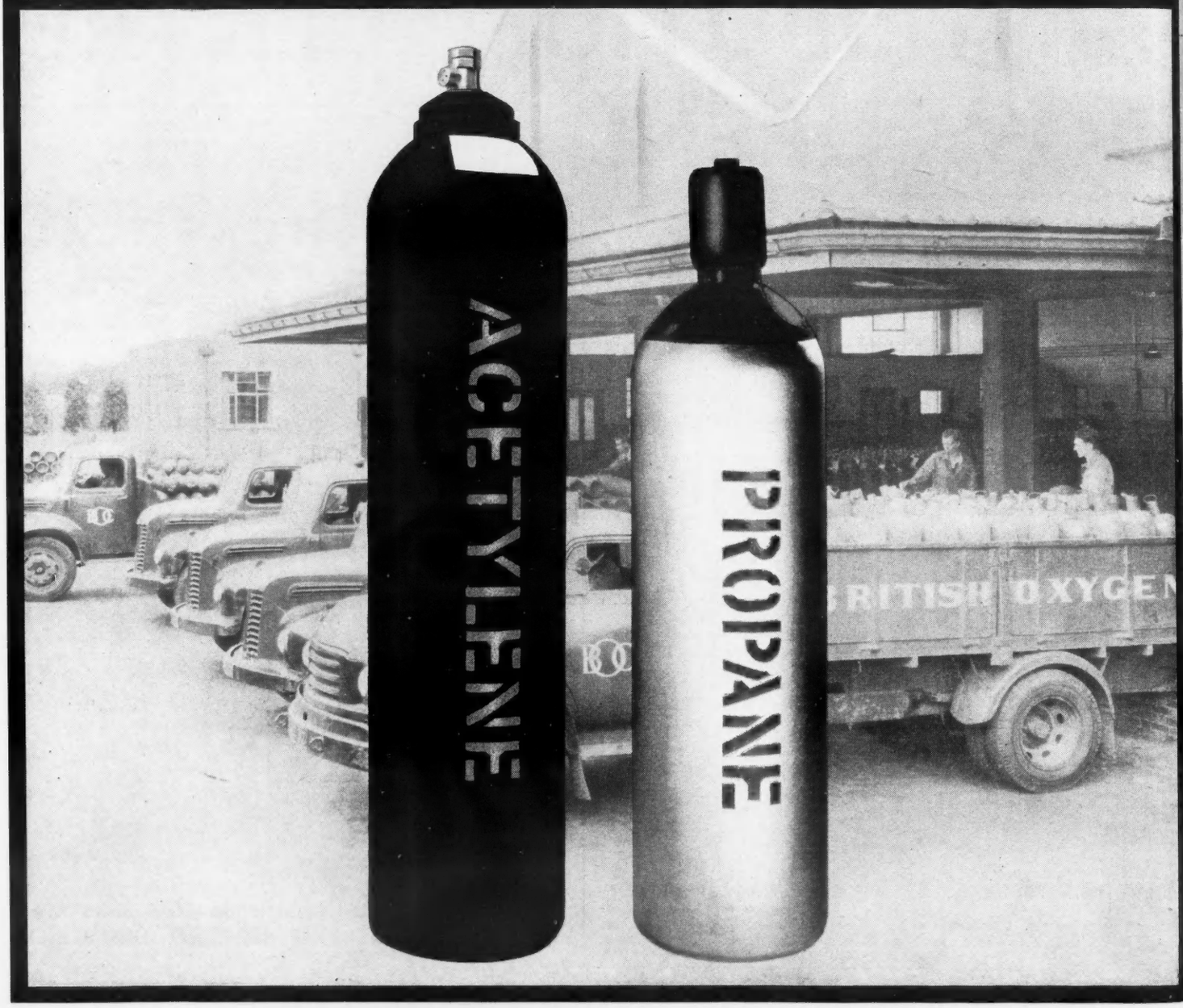
ACETYLENE or PROPANE?



For the right answer, for the right gas,
and for the best service—ask British Oxygen Gases

Does your type of production call for propane? acetylene? or both? British Oxygen Gases give will you an unbiased answer. Because British Oxygen supply gases for all purposes, they can help you from experience to choose the most efficient, most economical gas for your particular production needs. Only British Oxygen Gases have this breadth of experience and only British Oxygen Gases can offer you such a complete delivery service of industrial gases—in cylinders, or in bulk from their nation-wide tanker fleet—and lend you storage tanks as well if you need them.

BRITISH OXYGEN GASES LIMITED
27 ST. JAMES'S PLACE · LONDON · S.W.1

A BOC company

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OILGEAR
Fluid Power

THE WORLD'S MOST ADVANCED HYDRAULIC EQUIPMENT

ARE YOU TRYING TO:

- APPLY LARGE FORCES THROUGH LONG . . . . OR SHORT . . . . STROKES AT VARIABLE SPEEDS?
- OBTAIN AUTOMATIC WORK CYCLES, VARIABLE SPEEDS IN EITHER DIRECTION . . . . WITH OR WITHOUT PRE-SET TIME DWELL?
- APPLY LARGE FORCES THROUGH CONTINUOUS OR INTERMITTENT RECIPROCATING CYCLES AT CONSTANT OR VARIABLE VELOCITIES?
- OBTAIN EXTREMELY ACCURATE CONTROL OF EITHER POSITION OR SPEED OF A RECIPROCATING MEMBER?

You Need Oilgear!

Weatherley Oilgear Limited

HYDRAULICS DIVISION, BIGGLESWADE, BEDS.

TELEPHONE : 2351

(WOL. 1.)

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BRECO ROPEWAYS

WHEREVER INSTALLED USE GLOVER STEEL WIRE ROPES

FOR Maximum Dependability

Double G Aerial Ropes are specially designed for use on Aerial Ropeways and Cableways.

AERIAL ROPEWAYS & CABLEWAYS

CUT THE COST OF HAULAGE CONTRACTS

BRECO

the Big name behind the Big ropeways

Combined with the resources of
Drag Scraper & Conveyor Co. Ltd.,
specialists in Mechanical Handling Equipment.

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BRITISH ROPEWAY ENGINEERING CO. LTD.

PLANTATION HOUSE, MINCING LANE, LONDON, E.C.3.

Tel: MINcing Lane 7901. Telegraphic Address: Boxhauling, Fen, London.

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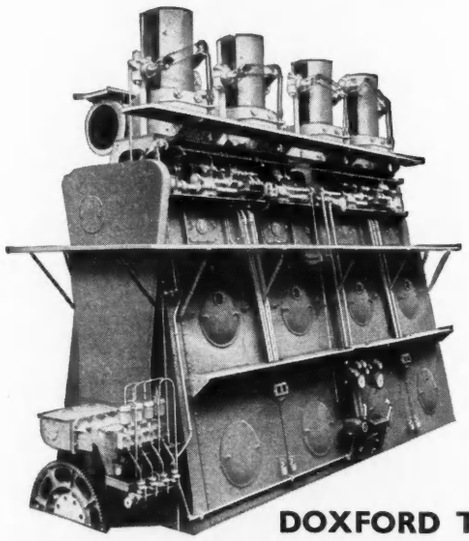
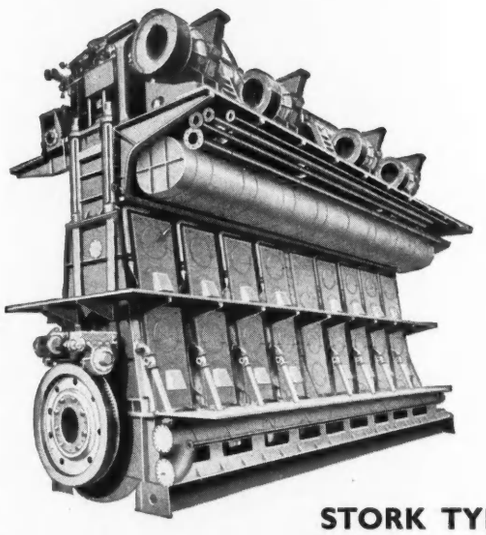
FAIRFIELD

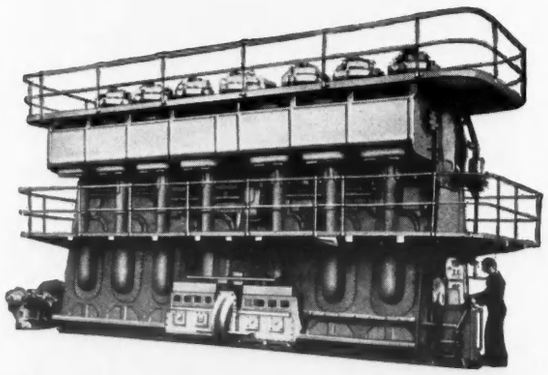
DIESEL MACHINERY



DOXFORD TYPE



STORK TYPE



SULZER TYPE

BUILT UNDER LICENCE

THE FAIRFIELD SHIPBUILDING & ENGINEERING CO., LTD.

GOVAN · GLASGOW

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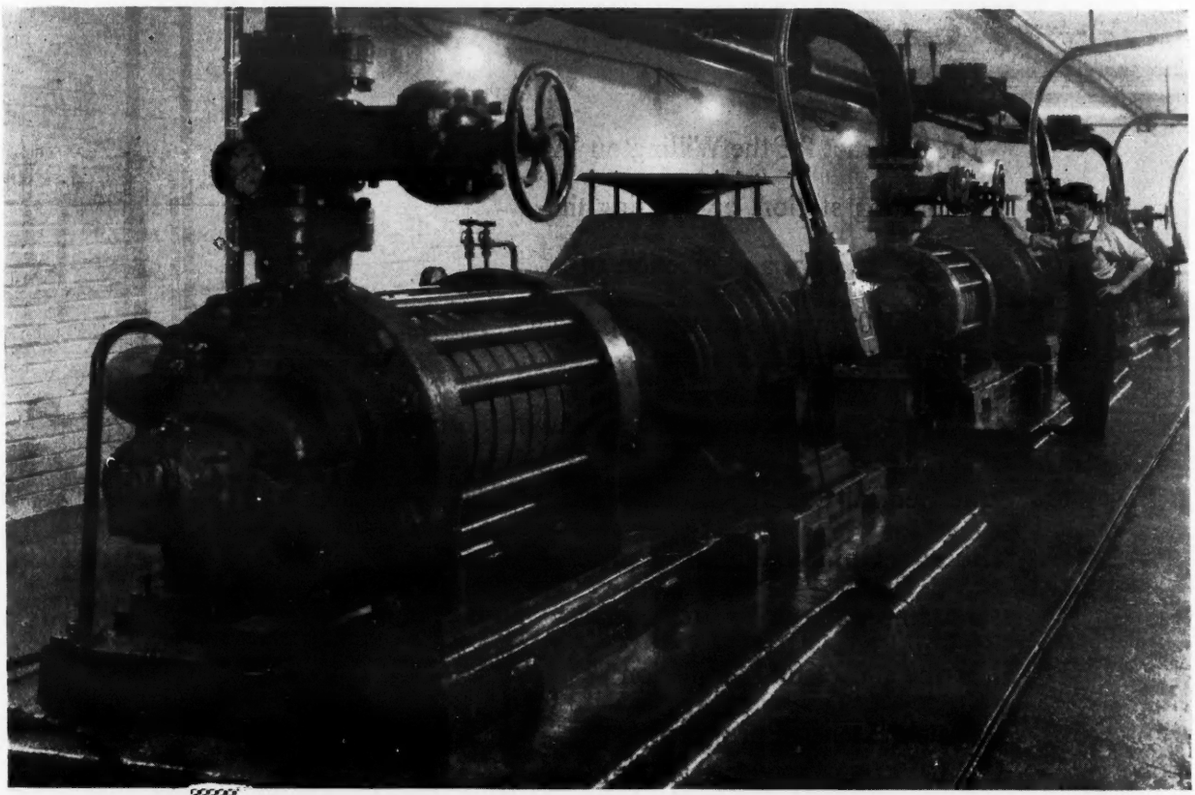
Mather & Platt
Pumps and Motors

SERVING THE MINING INDUSTRY



Mather & Platt electrically-driven pumping sets on drainage duty in a Scottish colliery. Each pump has a duty of 1000 g.p.m. against a 1550 ft. head, and is driven by a 3 phase, 50 cycles, 3000/3300v., induction motor. The motors are rated at 650 b.h.p., 1500/1480 r.p.m.

Mather & Platt LIMITED

PARK WORKS, MANCHESTER, 10.

Telephone : COLlyhurst 2321 Telegrams : Mather, Manchester.

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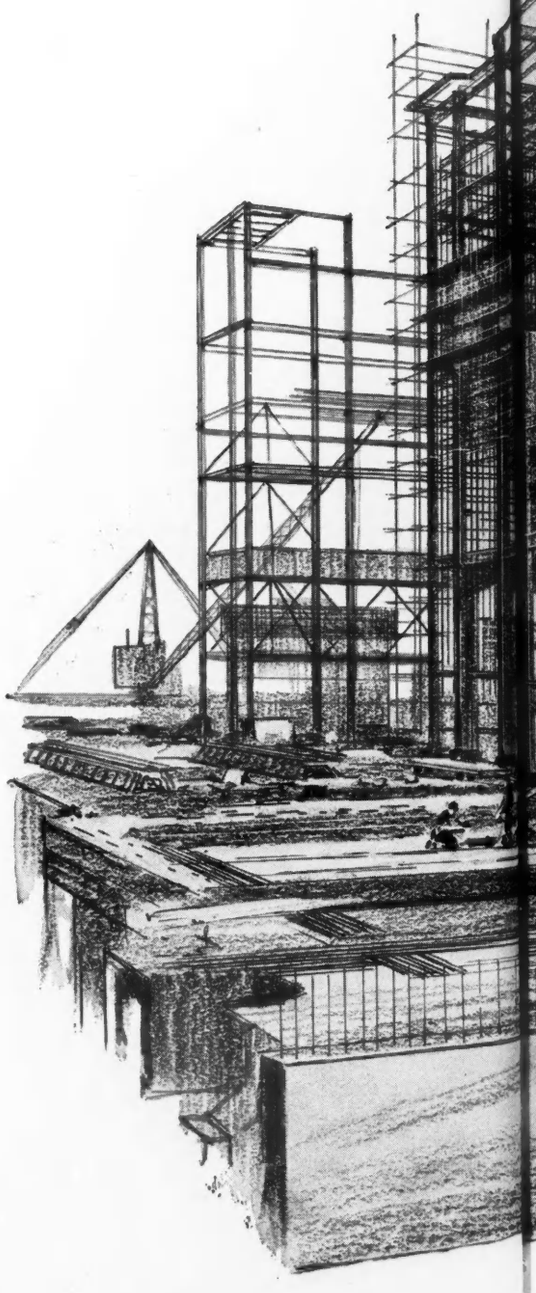

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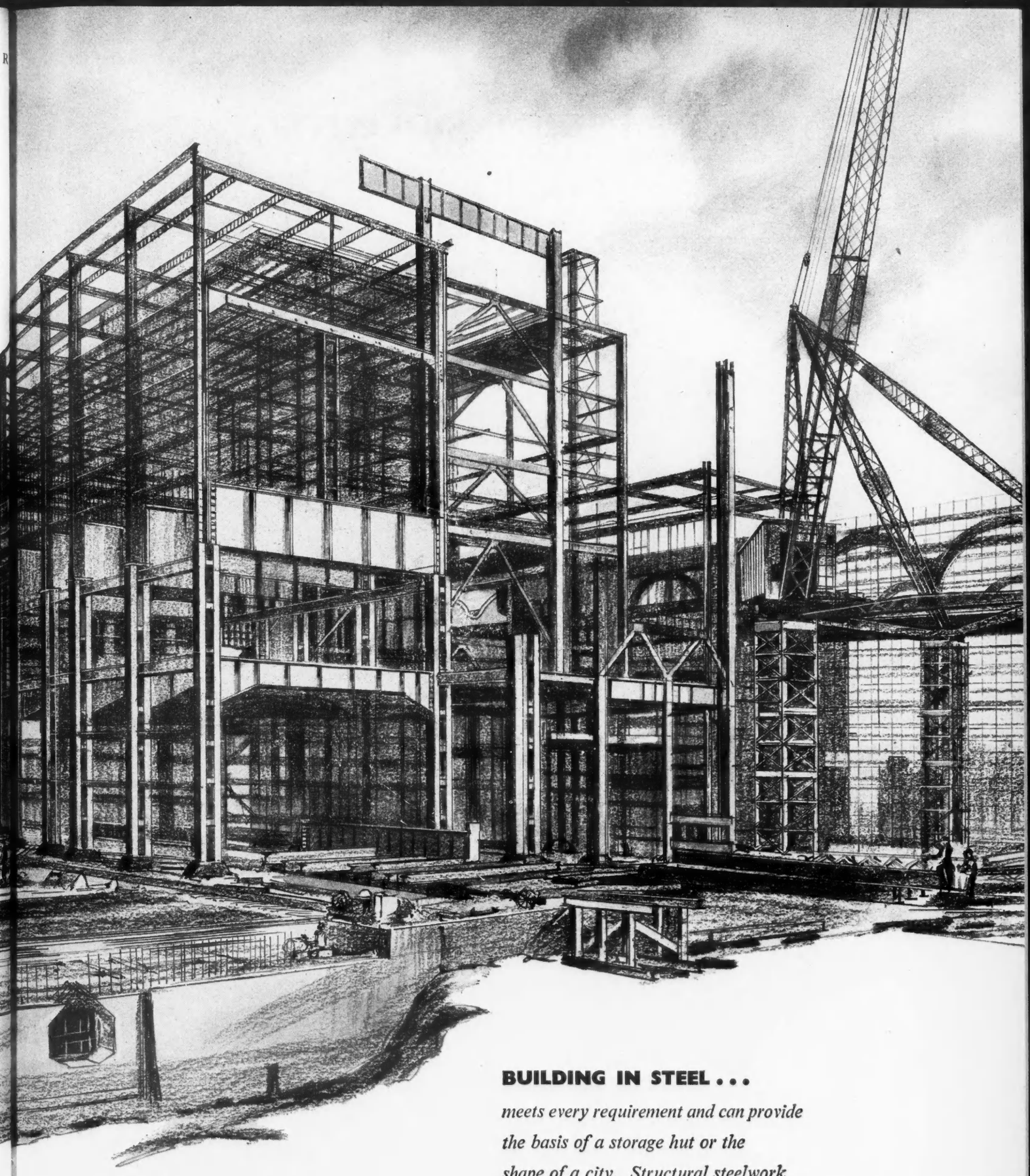

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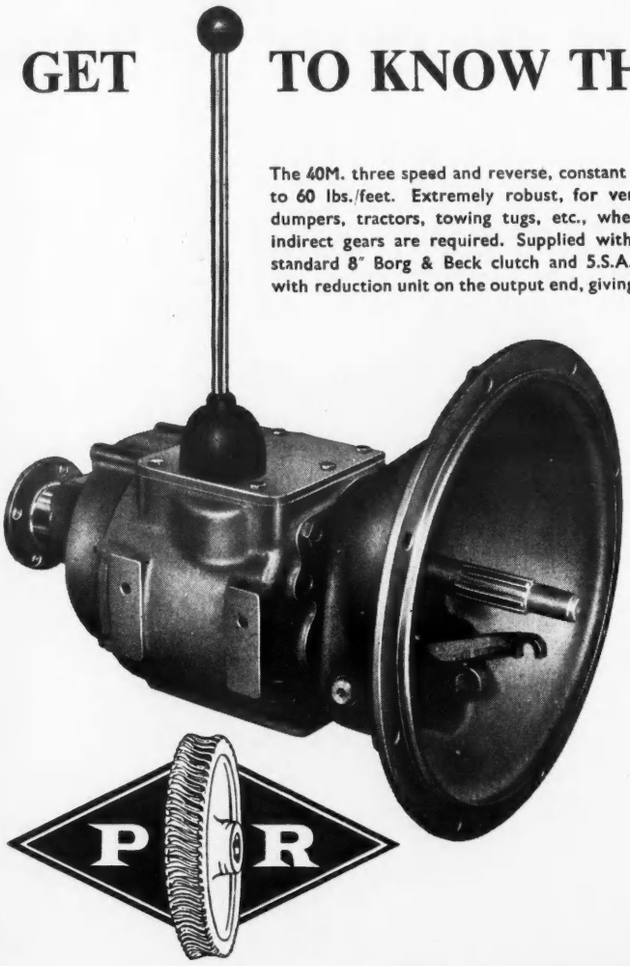

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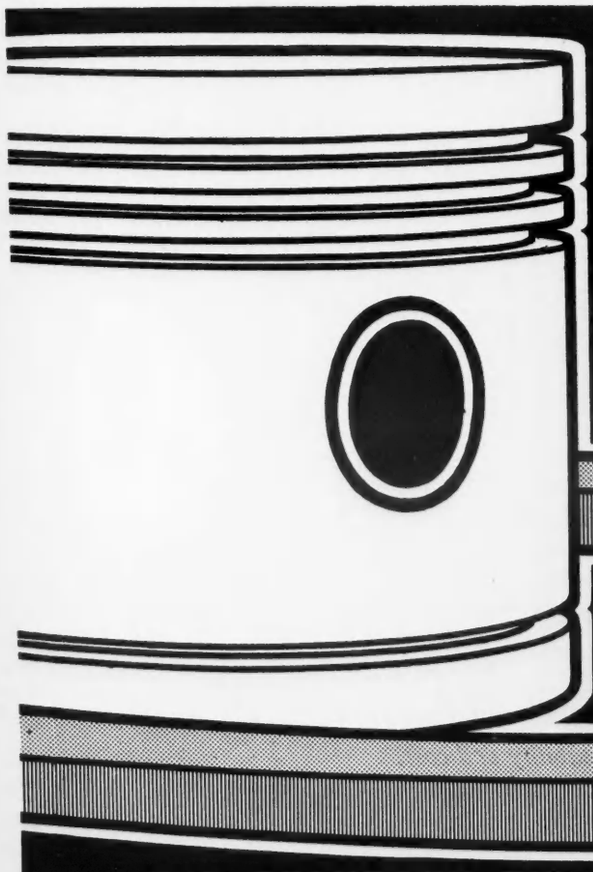

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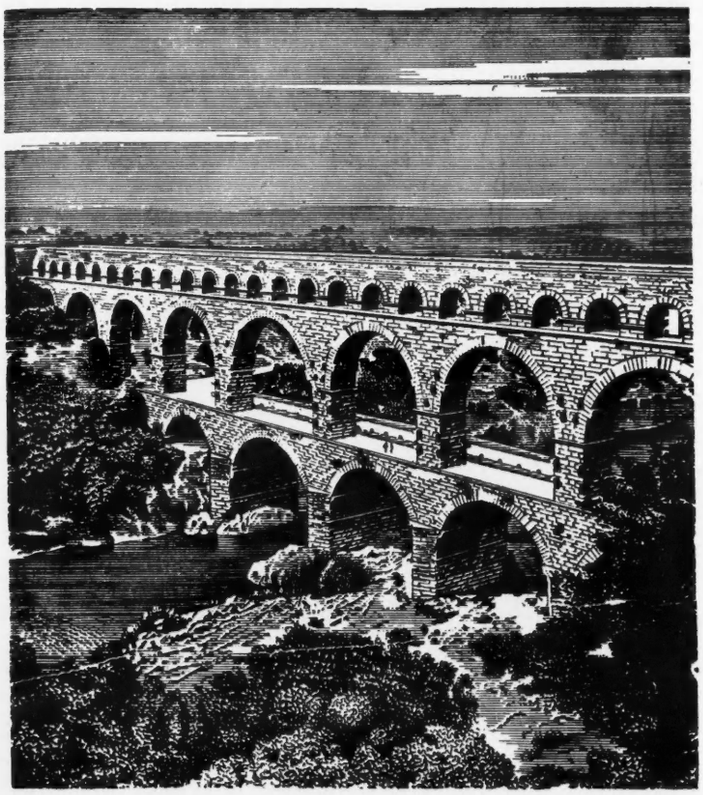

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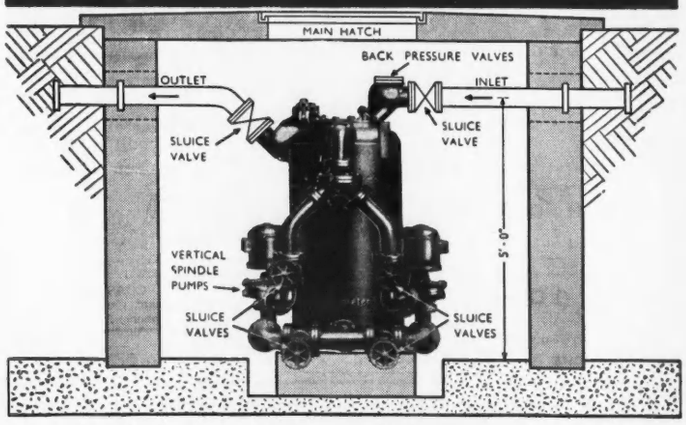

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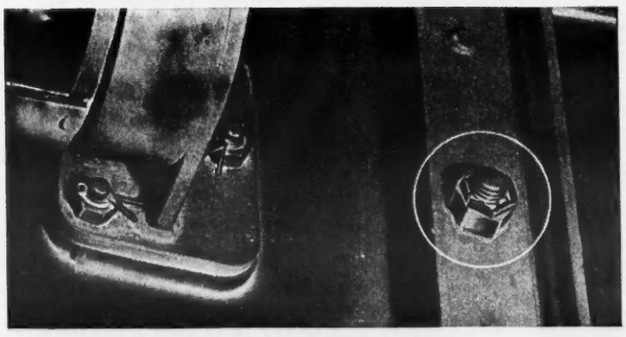

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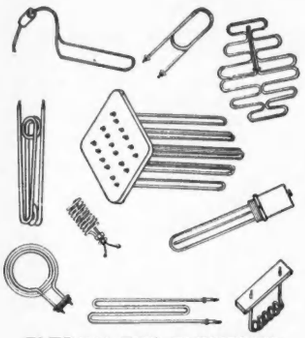

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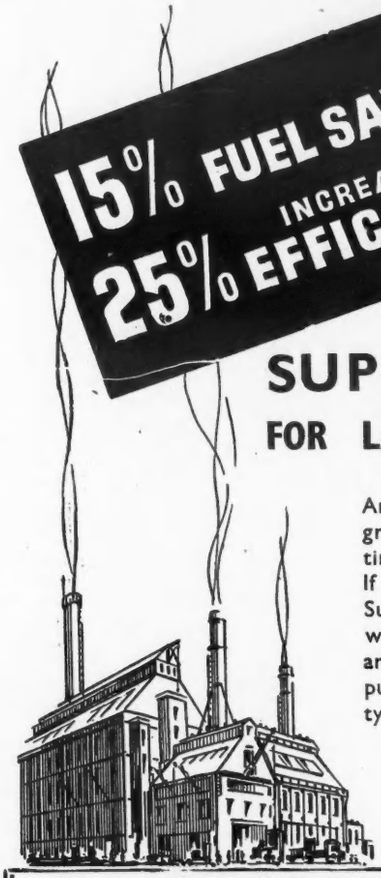

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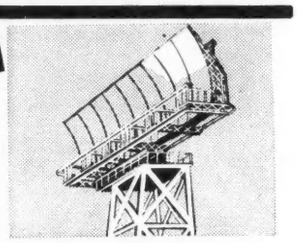

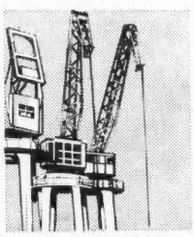

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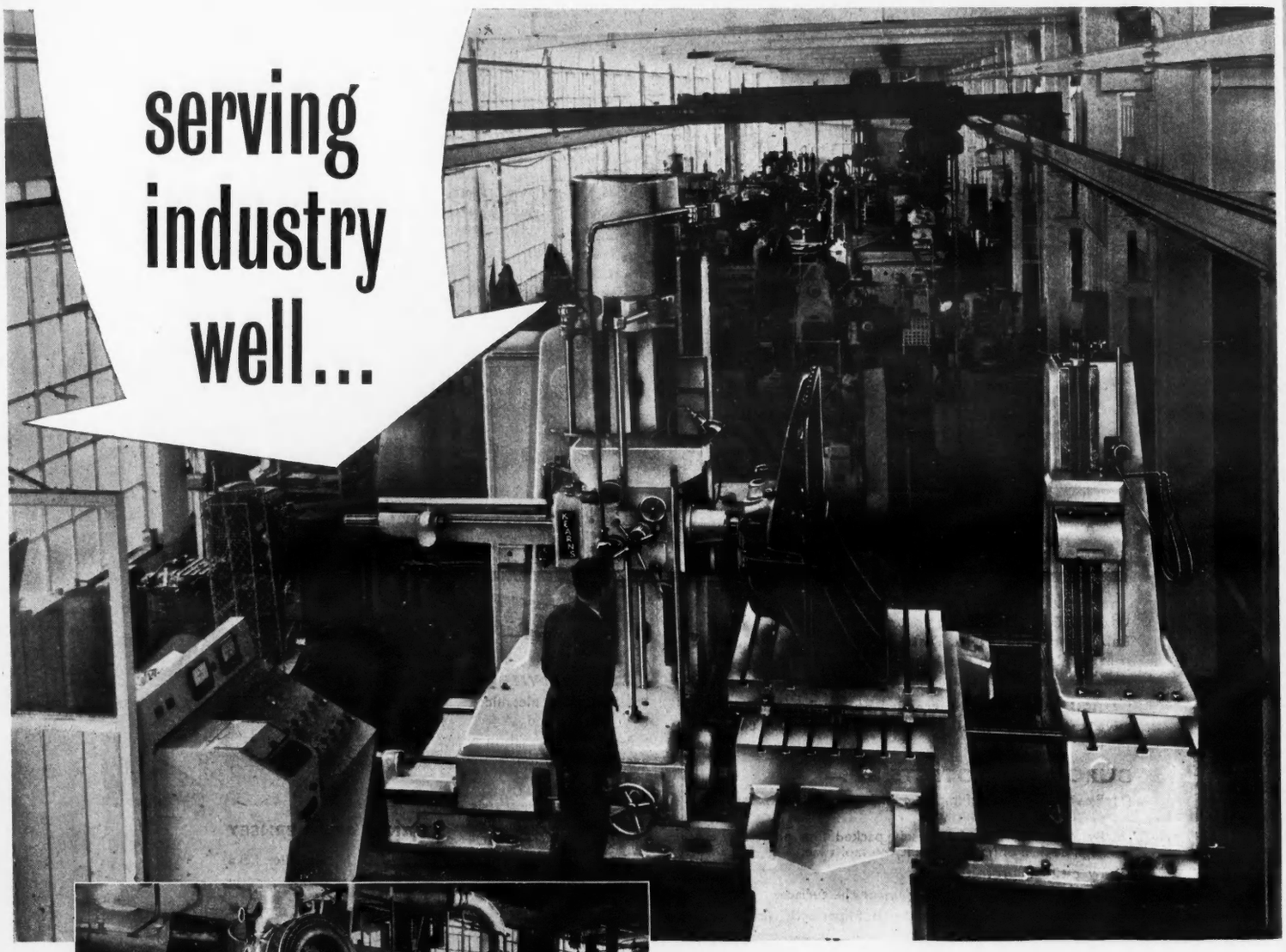

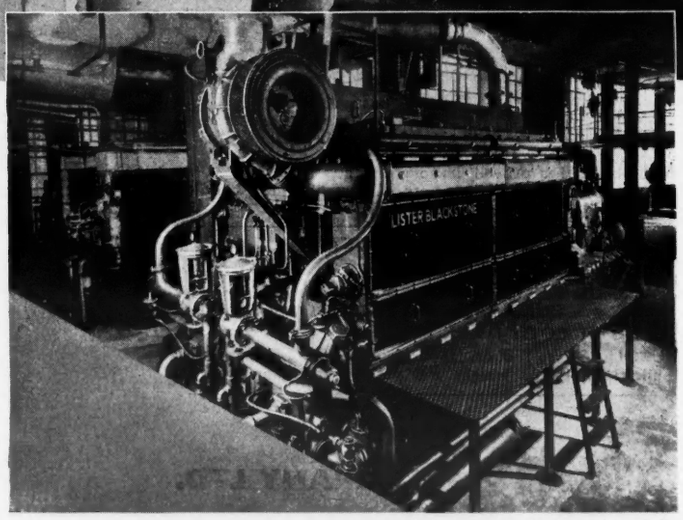

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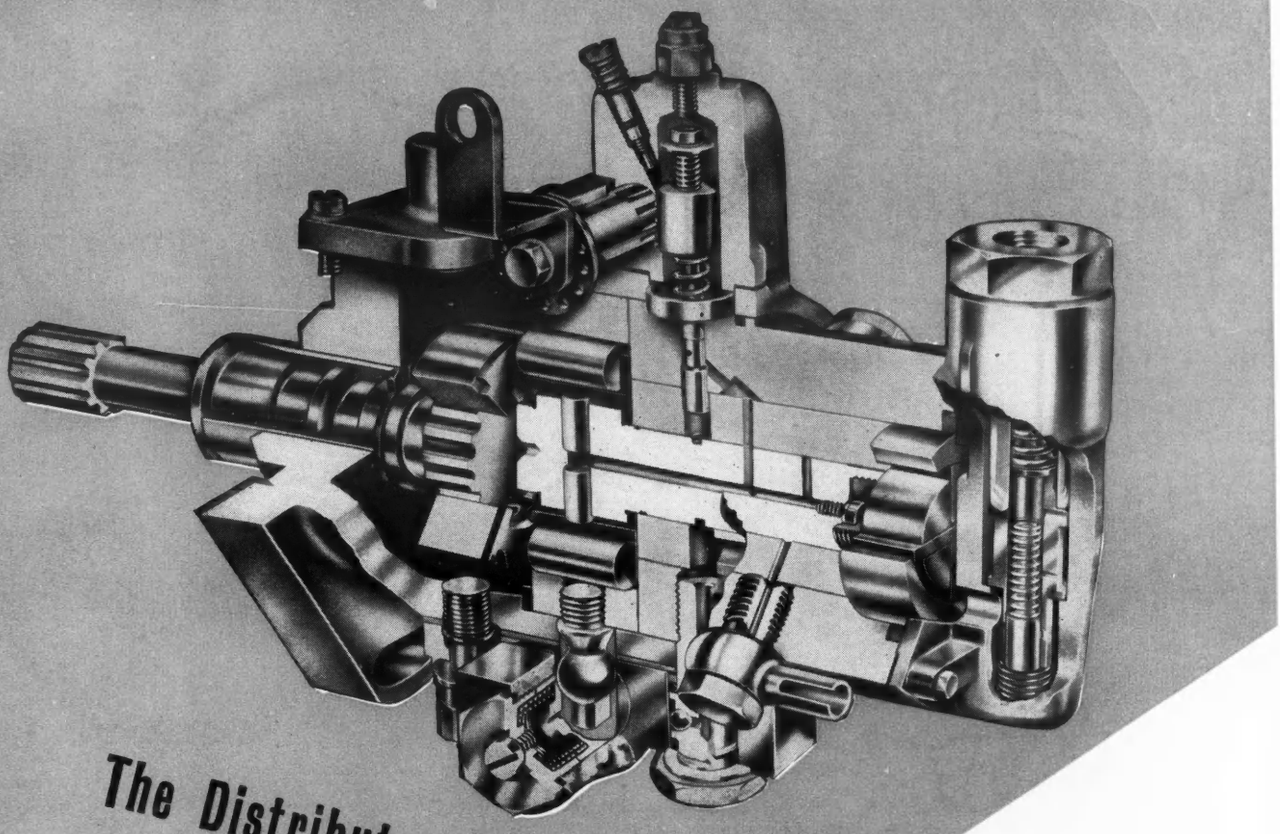
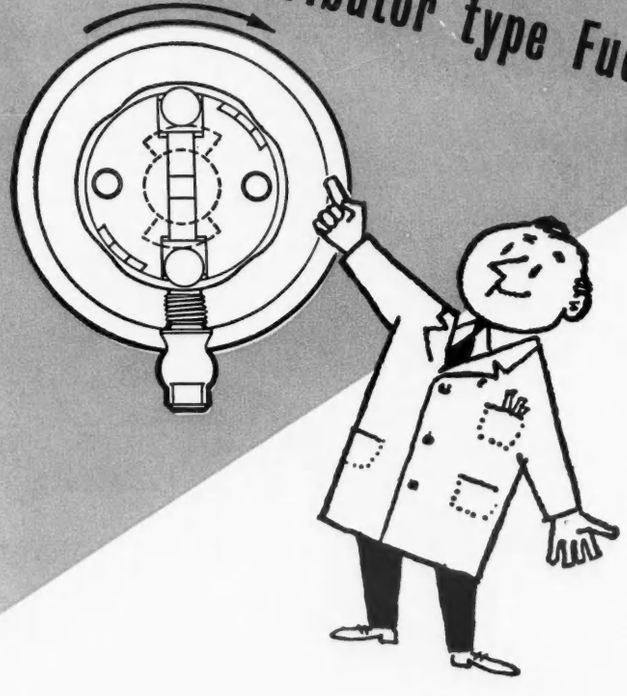


The Distributor type Fuel Injection Pump



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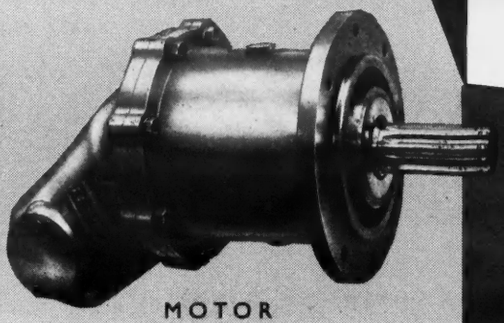

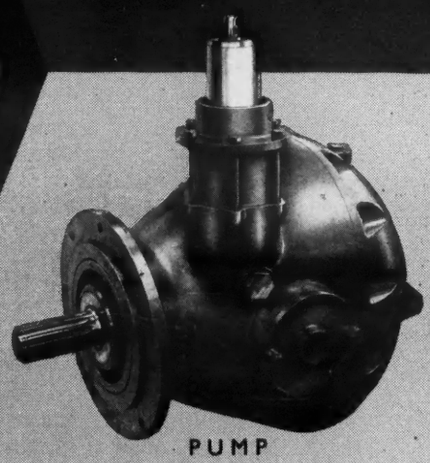

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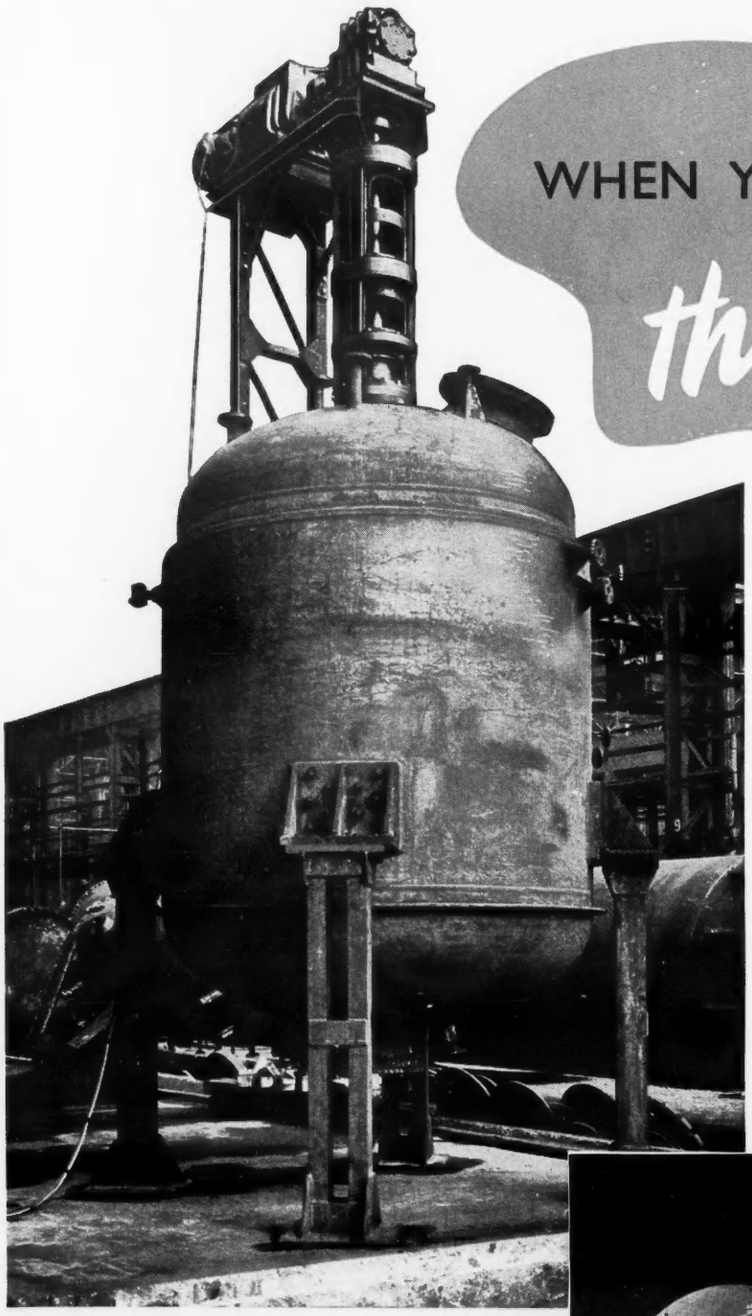

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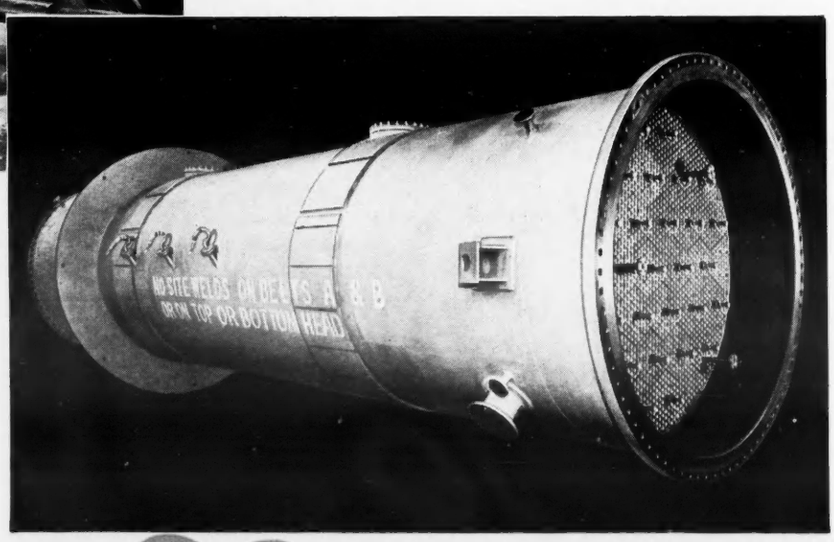

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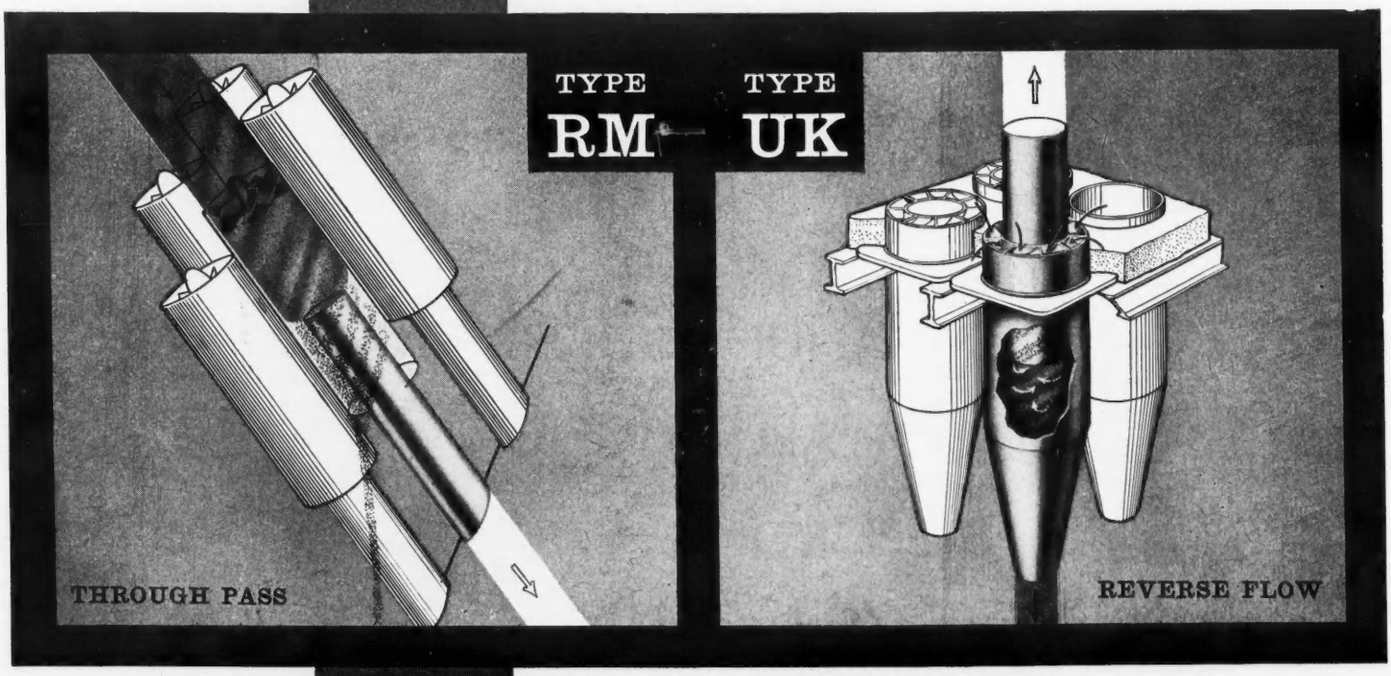

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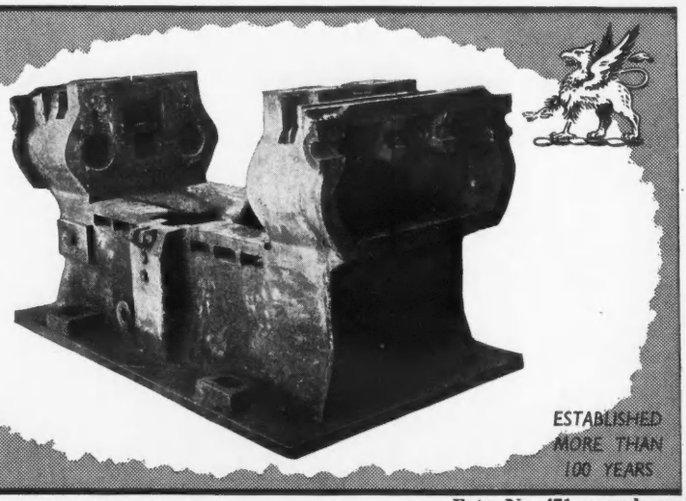

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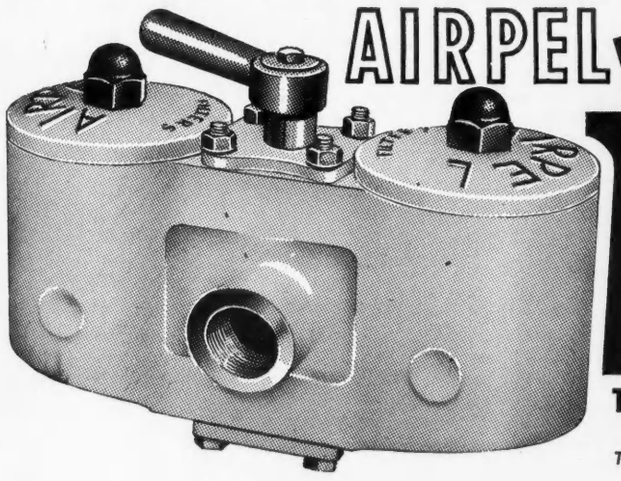

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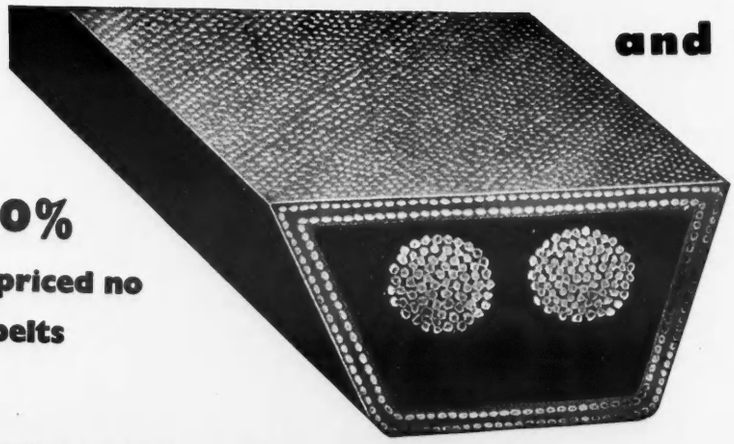

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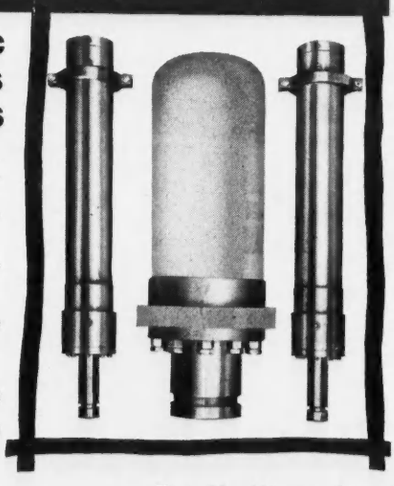

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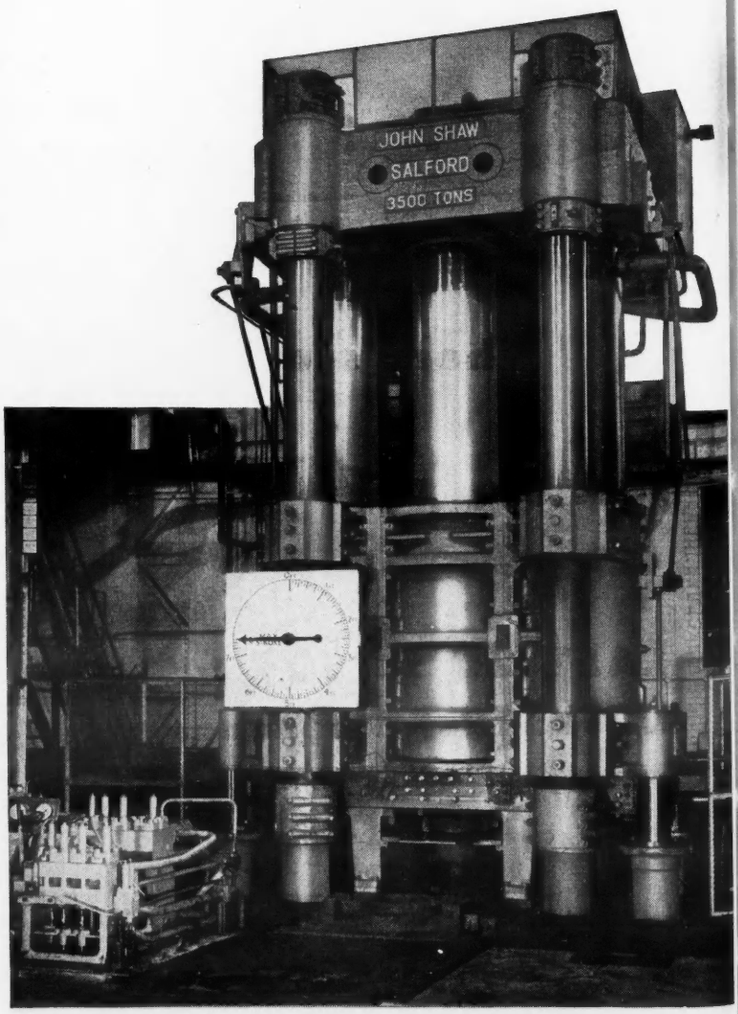
For whatever purpose you need a hydraulic press you will do well to consult JOHN SHAW.



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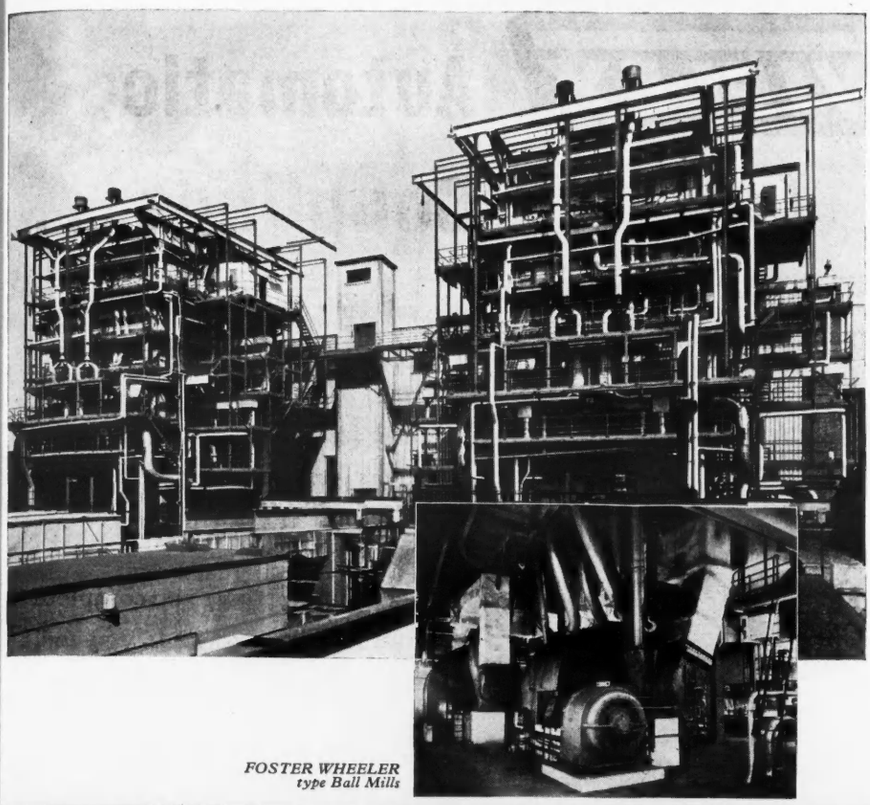

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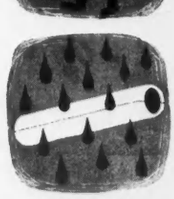

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Of major advantage on remote sites, NEWTHERM is unusually strong and rigid, and can withstand rough handling in transit and erection. In the case of vulnerable large-diameter sections, the hard surface offers excellent protection.

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Supplied in pre-formed sections and slabs, NEWTHERM is available in a wide range of standard sizes (and also as plastic). The smooth surface and straight edges permit easy and speedy fitting, with minimum joints and neat finish.

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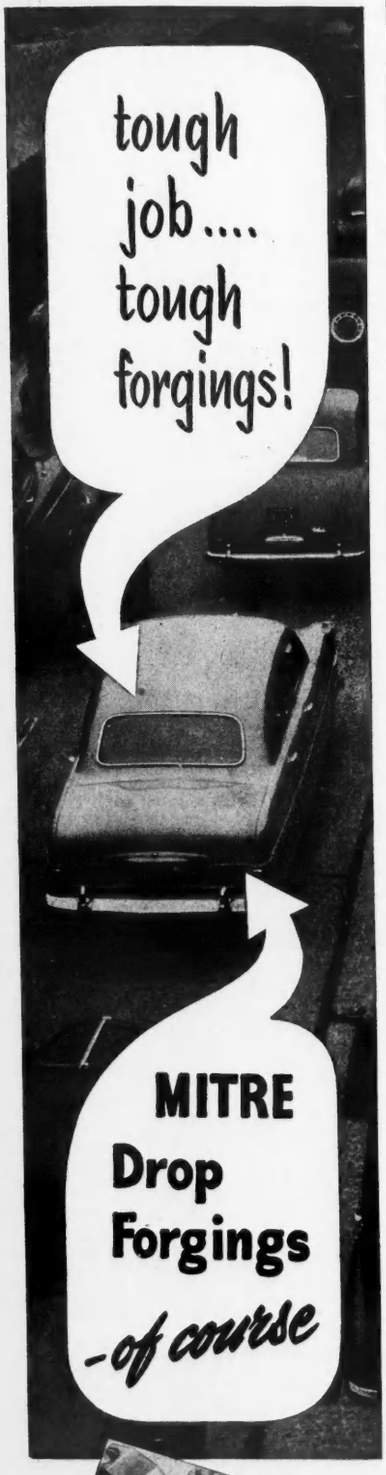

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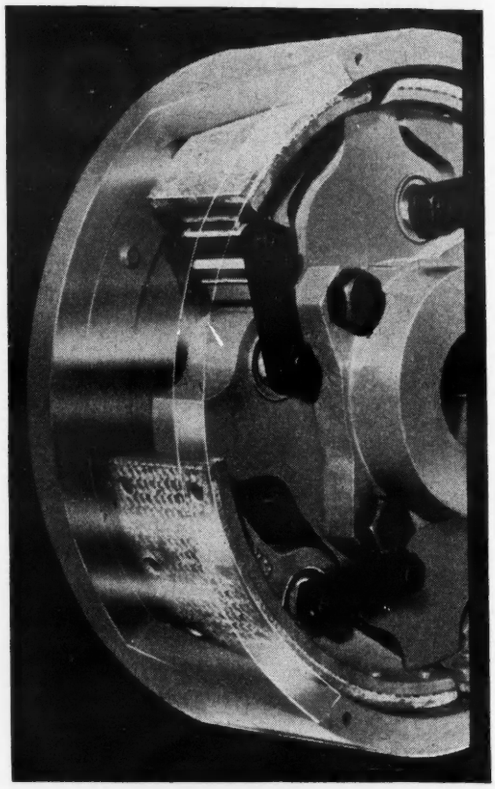

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Twiflex Couplings give you complete freedom at rest and at low speed, smooth take-up on acceleration, controlled overload slip characteristics *plus* flexibility in all directions.

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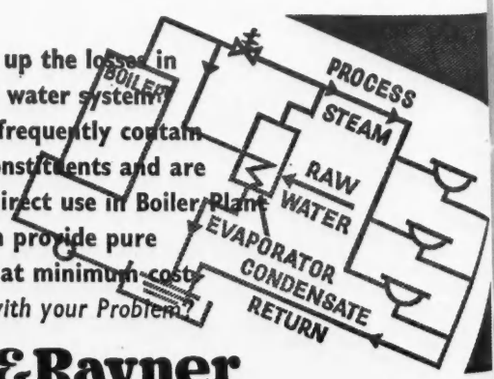

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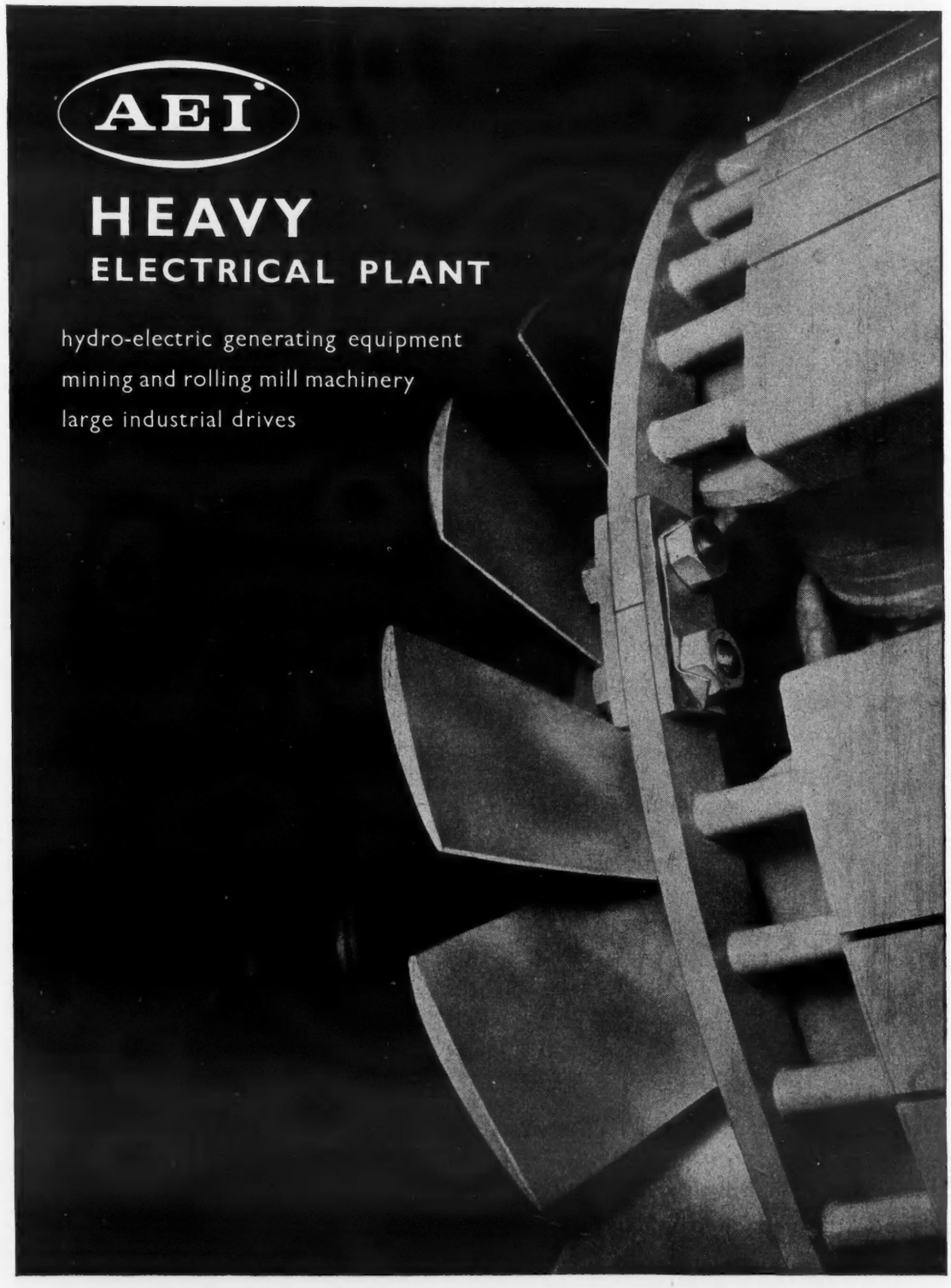

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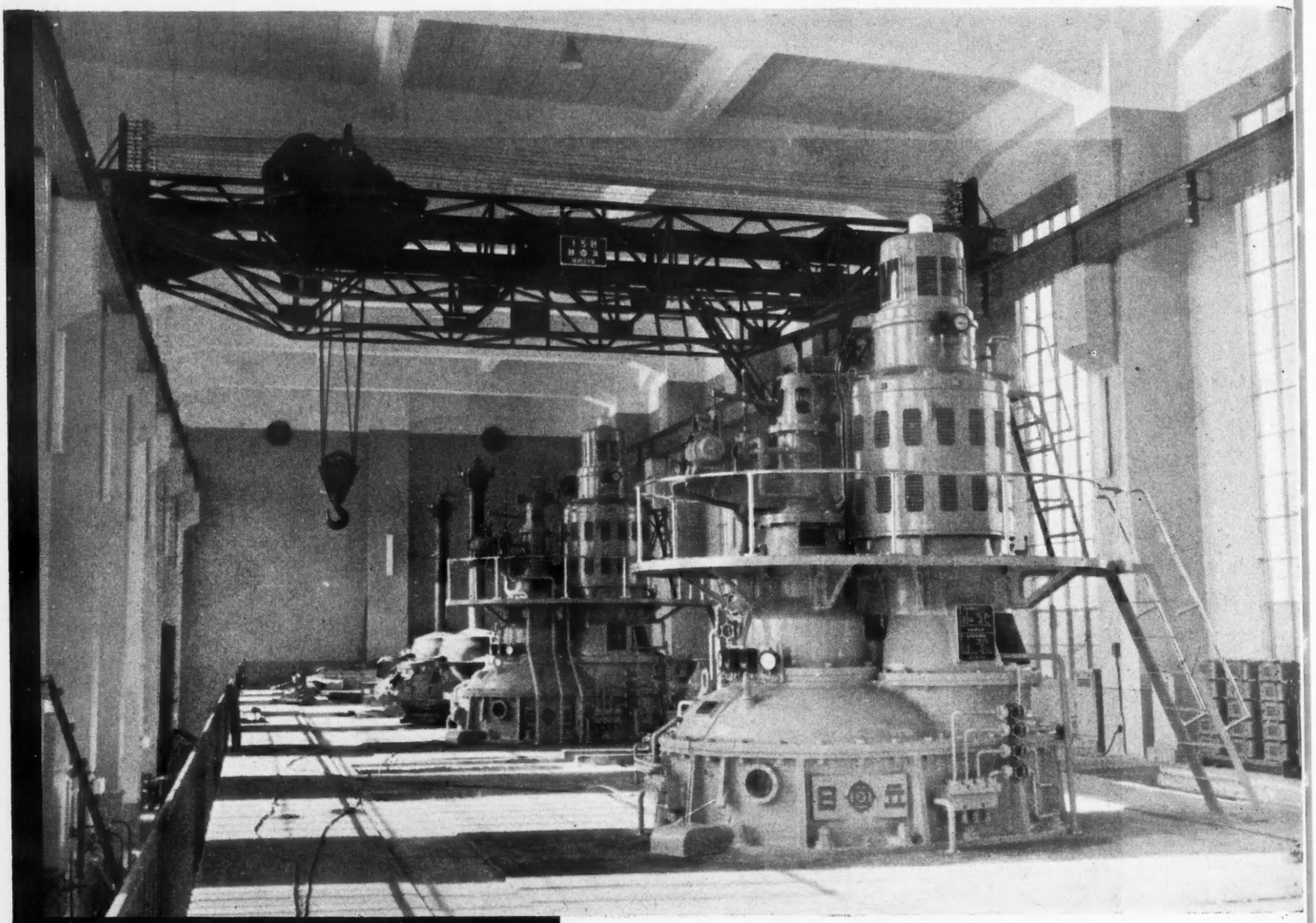

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Two Hitachi 2,800mm (approx. 9′ 2-1/4″) Axial Flow Pumps were recently supplied to the Imba Drainage Pumping Station which constitutes the nucleus of a massive reclamation project in the Imbanuma swamp area, Chiba prefecture, Japan.

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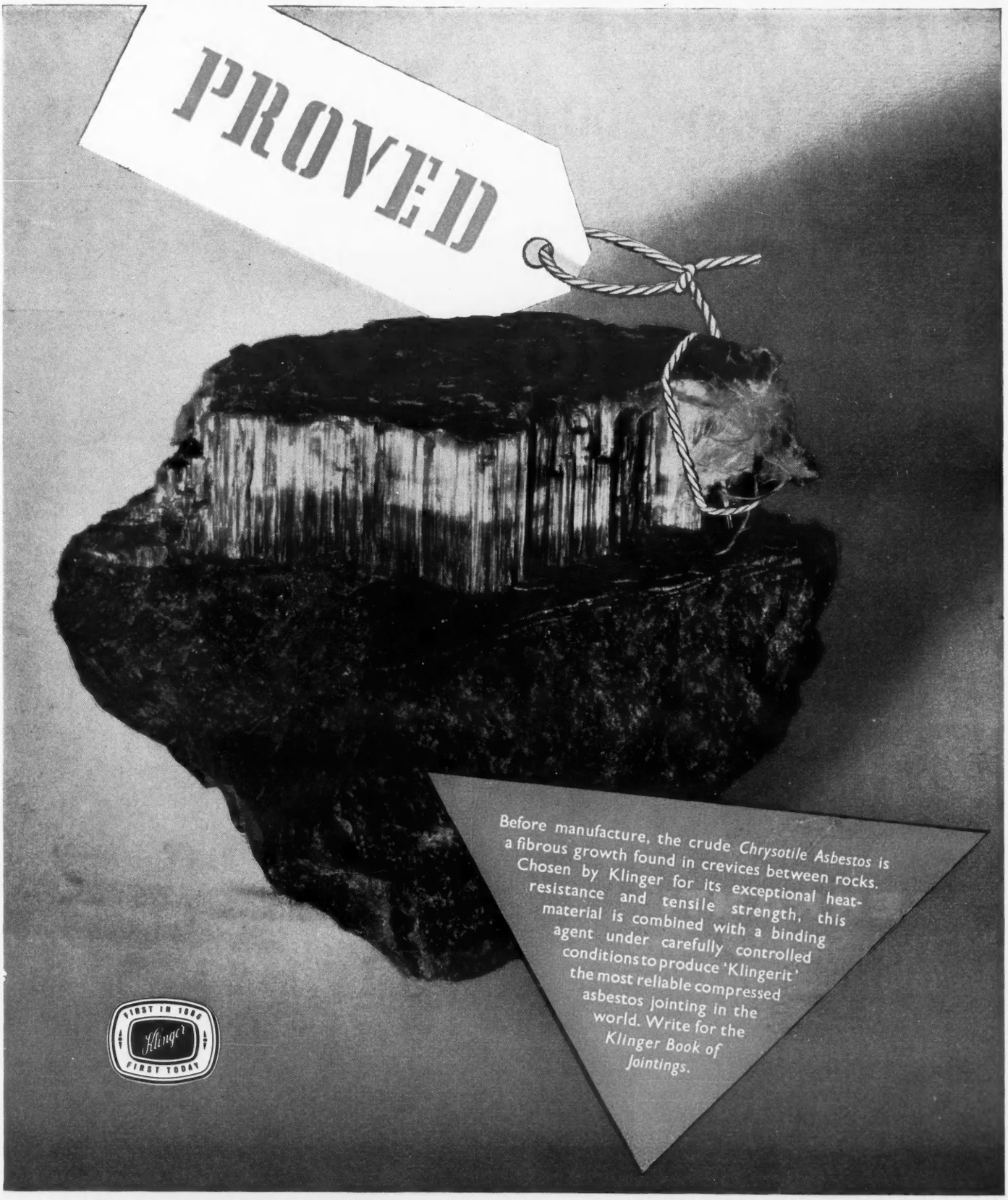
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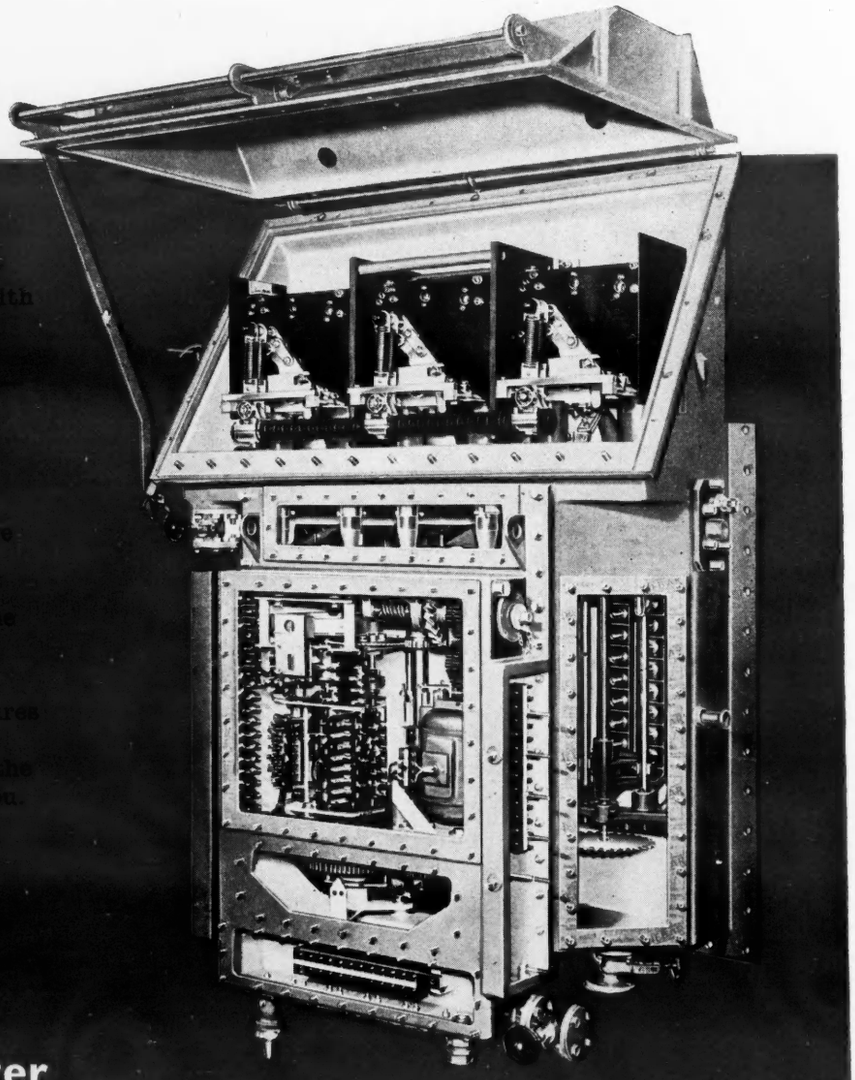

200,000 is a pretty impressive figure by any standard; but when it is linked with the number of operations carried out on the Ferranti D.C.3 Tap Changer using the same set of arcing contacts and this is a proven test, not an estimate of performance — it is an achievement which will readily be appreciated by supply engineers.

The tap changer performed an average of 380 operations per hour at a rating equal to full load on a 10 MVA 33 KV System Transformer, running over the whole range step by step in both directions.

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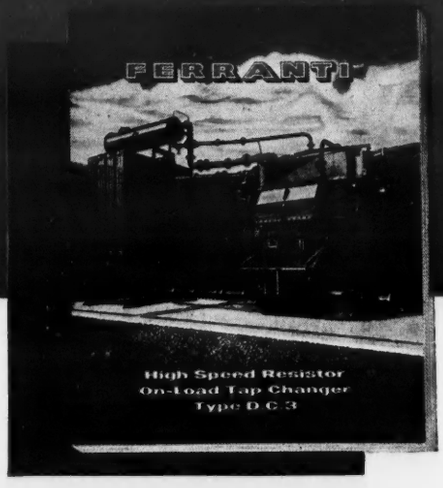

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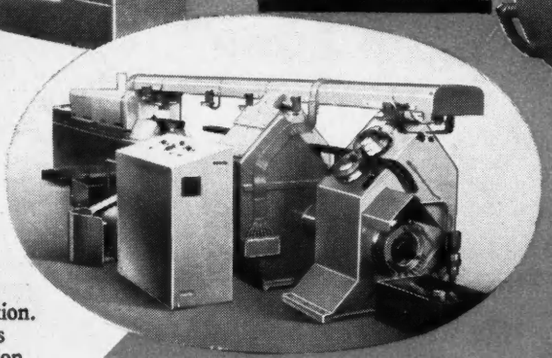

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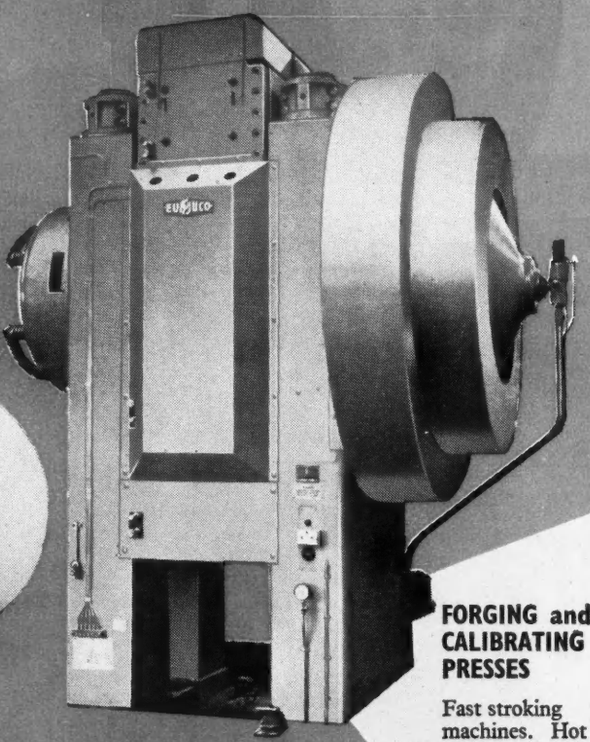

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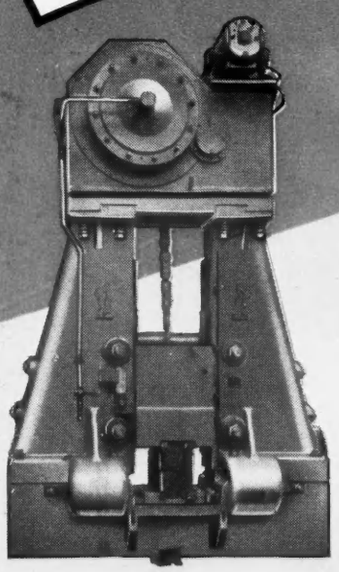

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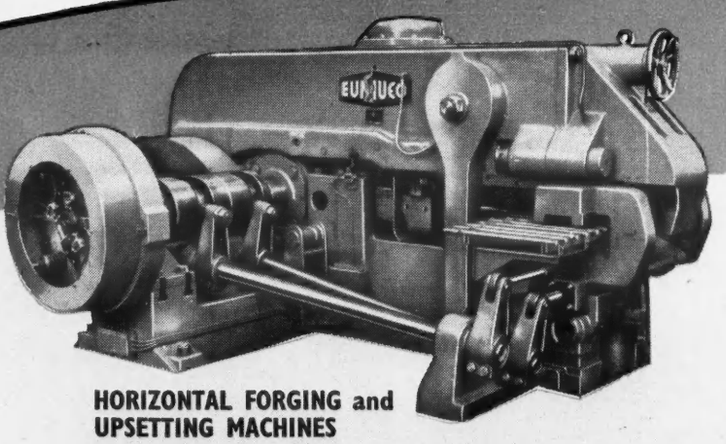

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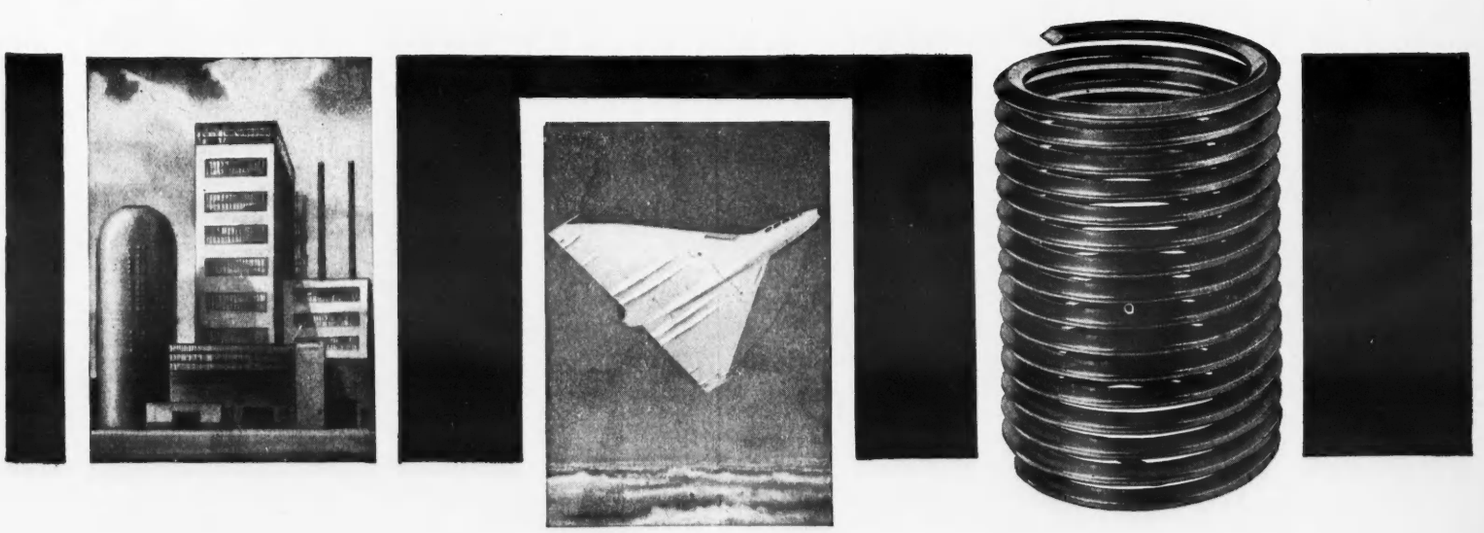

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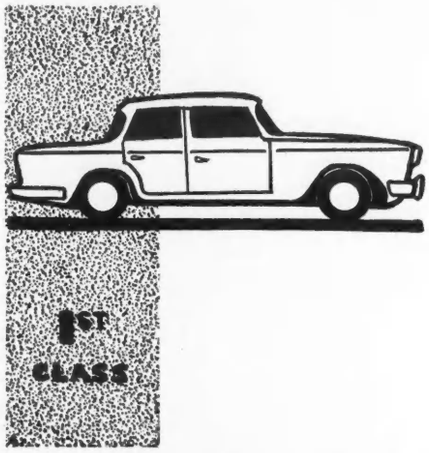

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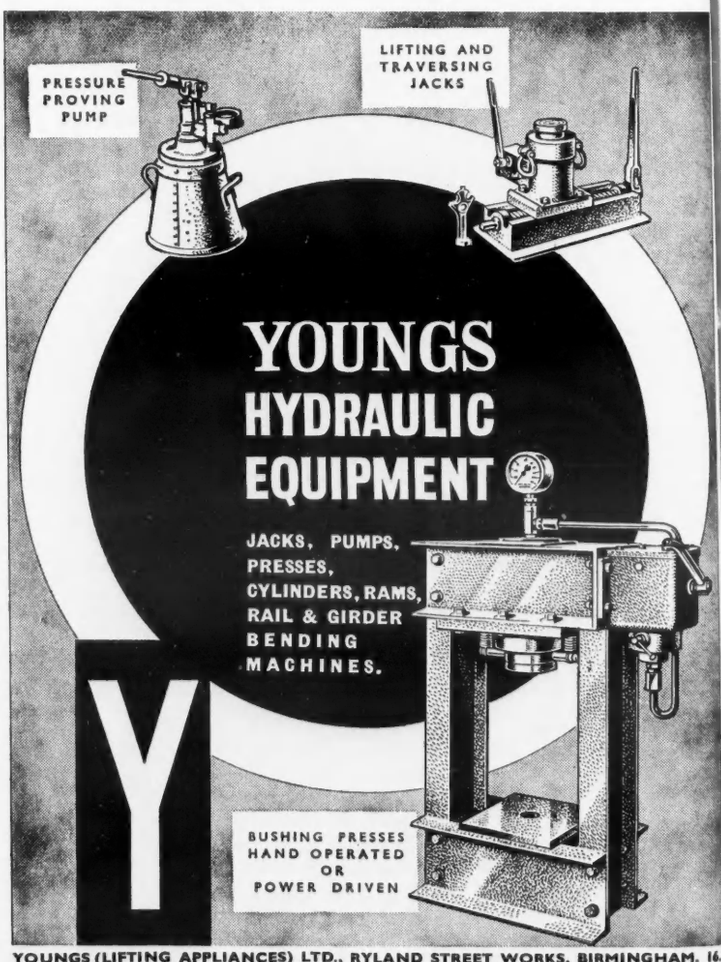

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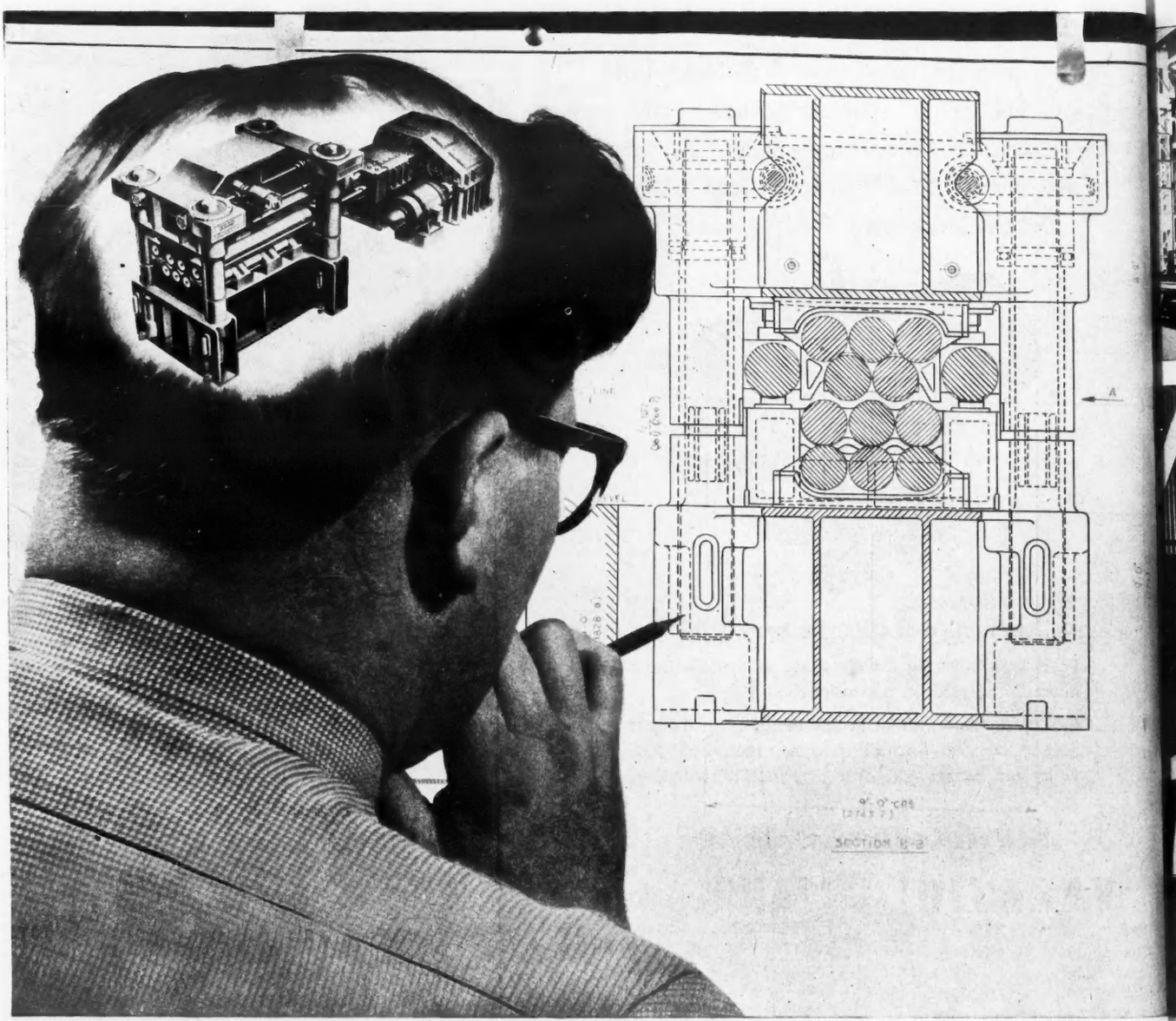

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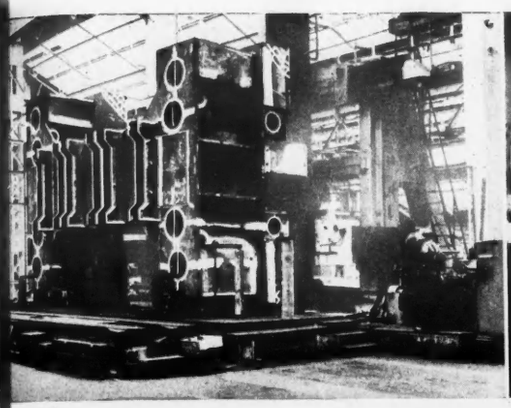
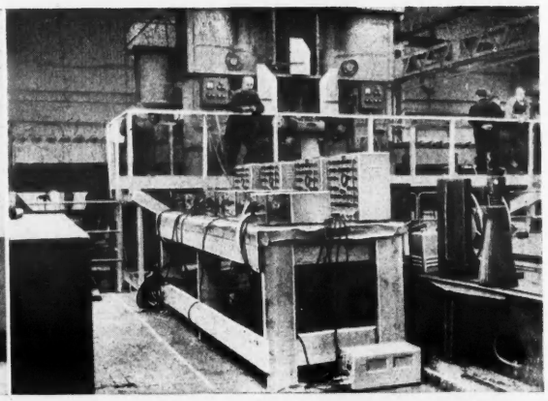
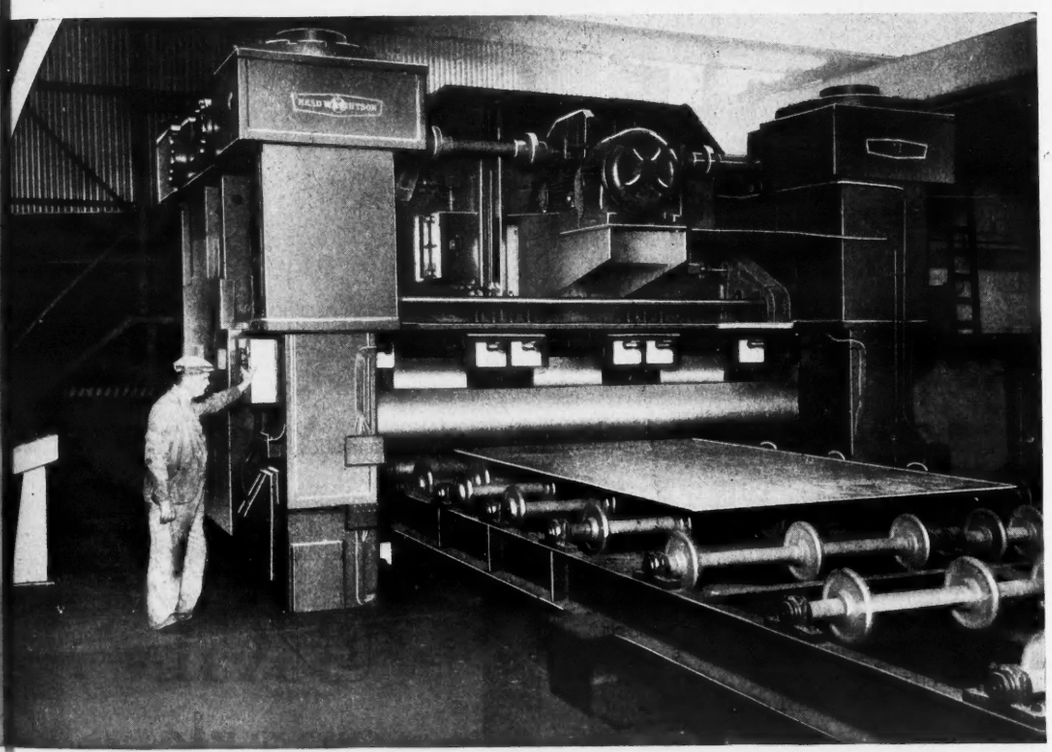




(Left) Leveller beam being machined.

(Right) The leveller undergoing fully instrumented tests prior to installation. Tests carried out with the assistance of the Group Research and Development Division.

(Below) The finished leveller installed and in operation.



Working from basic details, The Head Wrightson Machine Company Ltd. carry through the design and manufacture of capital equipment from enquiry to installation. This ability for creative engineering is well demonstrated by the Heavy Plate Leveller (to handle plates up to 2″ thick by 12′ 0″ wide) recently installed at the Wallsend Shipyard of Messrs. Swan, Hunter & Wigham, Richardson which was designed and constructed by the Head Wrightson Machine Company.

In order to build this leveller it was necessary to prepare an entirely new design in close collaboration with the Research and Development Division of the Head Wrightson Group of Companies.

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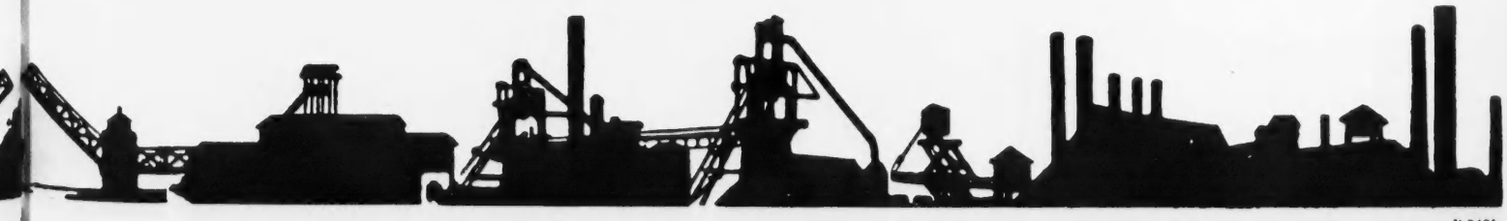

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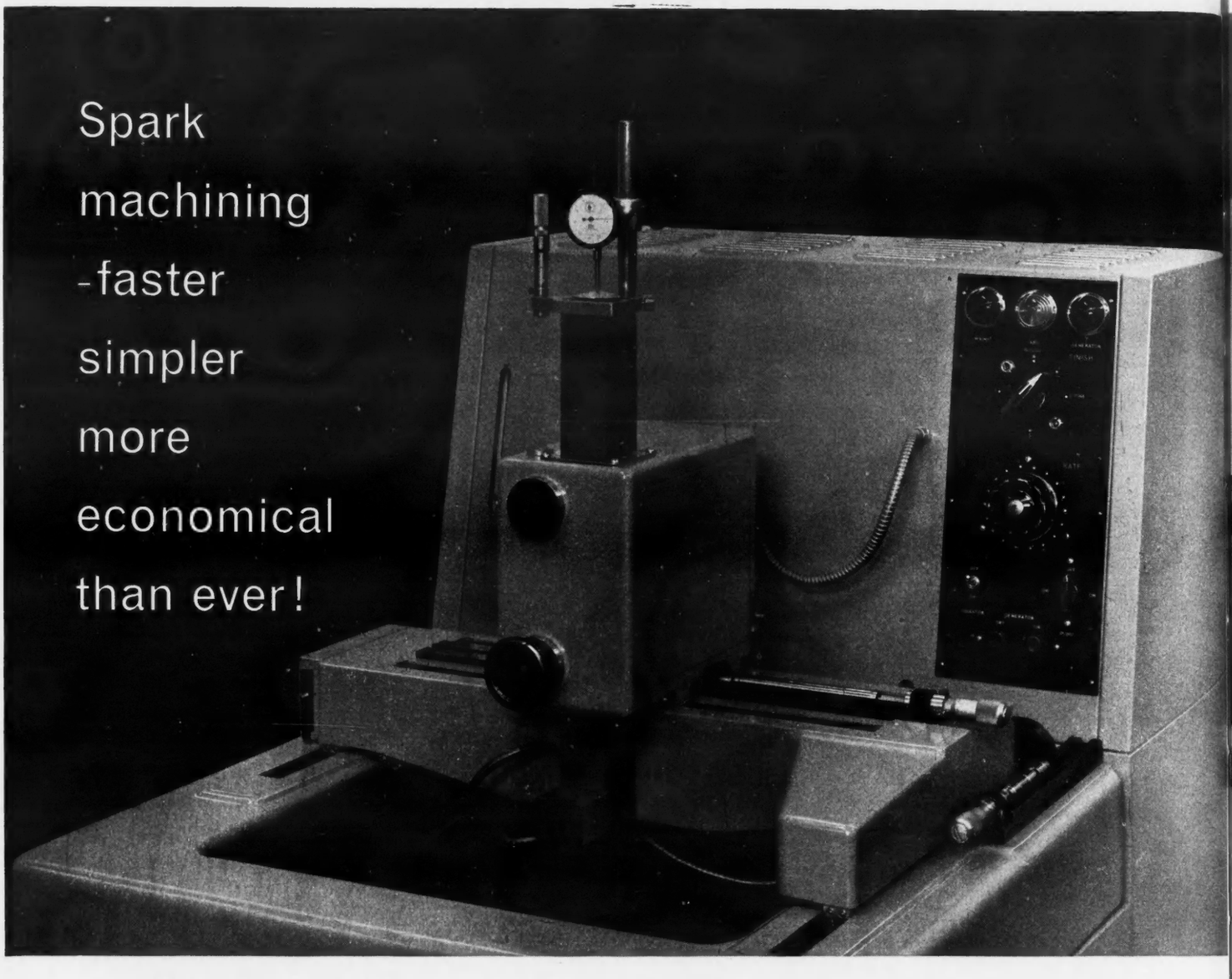

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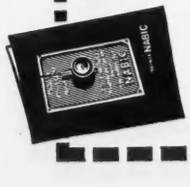

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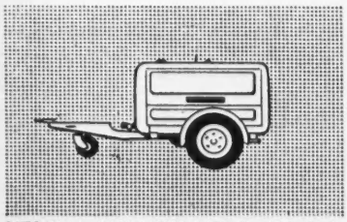
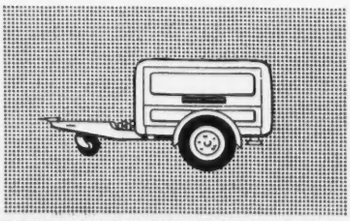
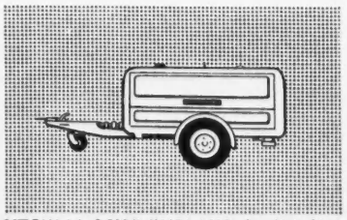


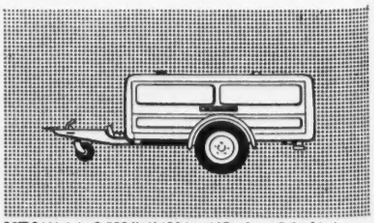
VT3 Weight 2,180 lb (990 kg) 115 c.f.m. (3,2m³/m)



VT4 Weight 2,310 lb (1050 kg) 160 c.f.m. (4,5m³/m)



VT5 Weight 2,900 lb (1315 kg) 225 c.f.m. (6,4m³/m)



VT6 Weight 3,590 lb (1630 kg) 315 c.f.m. (8,9m³/m)

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THE ENGINEER

No. 5449 JULY 1, 1960 Vol. 210

"MECHANICALS" IN IRELAND

A Summer Meeting of the Institution of Mechanical Engineers usually accords with an habitual pattern. The members gather on the Monday, there being some evening function on that day; there is an official "opening" ceremony followed by a technical session on Tuesday morning; visits to works are made on that afternoon and on the following days; and on the last day, sometimes Thursday, sometimes Friday, sightseeing tours predominate over works visits. Pleasure, it will be observed, has to wait upon the satisfactory completion of business. But, of course, things are always a bit different in Ireland, where the members went for a Summer Meeting last week. The official "opening"—a Civic Welcome by the City of Belfast—occurred on Monday afternoon and was followed by the technical session. Thereafter pleasure at once intervened; on Tuesday there were arranged a variety of sightseeing tours to parts of Northern Ireland! Visits to works were made all-day on Wednesday and again on Thursday morning. On Thursday afternoon most of the members transferred to Dublin—or rather to Dun Laoghaire—by train where the official "opening" took the form of a Reception in the delightful surroundings of Dublin Castle by invitation of the Minister of Transport and Power, Mr. Erskine H. Childers. On the Friday, apart from a sight-seeing tour to Glendalough, intended, no doubt, for the ladies, (but patronised by a number of members too!) there were works visits for all.

The trouble about success, of course, is that it is not news. Had the members suffered trials and tribulations, had the organisation failed, had the luggage been lost between Belfast and Dun Laoghaire, had there been interminable delays, had the rain poured down remorselessly all day and every day as it can for day after day in Ireland, we should have had plenty to say. But in fact we heard only one complaint. It related to hotel accommodation at Dun Laoghaire. From the moment on the Monday when the members and their ladies gathered in the City Hall at Belfast to eat a buffet lunch by invitation of the Belfast City Council, to the small hours of the Saturday morning when members and their ladies came away from a buffet supper dance held in the Zoological Gardens at Dublin, by invitation of a group of State sponsored bodies, everything went off like the proverbial clockwork. Congratulations are certainly due to all concerned with organisation. It was a Summer Meeting which will, we think, be remembered with pleasure by all who attended it; and the Institution members and their ladies will hope it also proved memorable and pleasing to their hosts both North and South of the border. In the Supplement which we published a fortnight ago in connection with the Meeting we suggested that English, Scots and Welsh engineers were not very well informed about the work of engineers in Northern Ireland and the Republic. Certainly the visit will have helped to remedy that situation. There is no doubt that the members were much impressed by what they saw and equally impressed to learn about the opportunities for industrialists and the aid provided for the setting up of new works both North and South of the border.

IRON AND STEEL REPORT

The main duty of the Iron and Steel Board is "to exercise a general supervision over the iron and steel industry with a view to promoting the efficient, economic and adequate supply, under competitive conditions, of iron and steel products." The Board is required to submit an annual report to the Minister of Power as to the ways in which it fulfils its duties. The report for 1959 was published last week. Not only does it show how the iron and steel industry got back into its stride after several months of temporary recession; it emphasises also the progress of further development and planning for the future to ensure that likely demands can be met. Thus, throughout last year the Board continued its examination of the possible demand for iron and steel products in the middle 1960s and onwards to 1970. That examination is still going on in conjunction with the Government departments concerned, with consumers and with the industry itself. As soon as broad conclusions have been reached as to the probable demand for the main products, the Board will invite manufacturers to give an indication of their future production and their plans for expansion, so that a further development report can be prepared.

That document is one which is awaited with interest. The present position is that, on the basis of projects now approved, crude steel capacity (25,500,000 tons in the present year) is calculated to approach 29,000,000 tons in 1962 even after allowing for possible delays in the construction of new plant. Looking further ahead, the Board suggests that a production of at least 32,000,000 ingot tons in 1965 appears possible. Last year, the iron and steel industry's capital expenditure was in the region of £99,000,000, compared with £105 million in 1958. This year, the Board estimates that the industry's capital expenditure will turn out to be " substantially higher " than in either of the last two years. In this context, it is interesting to note that the estimated capital cost of the forty-six development projects approved by the Board last year is £200 million. Thus, there continues to be shown that confidence about its future which has been characteristic of the British iron and steel industry since its first development programme was put in hand in 1946. It does not shrink from its responsibility to look ahead, in spite of periodical applications of the brake upon the national economy by the Chancellor of the Exchequer! But the Iron and Steel Board's latest report is not confined exclusively to the industry's economics. Far from it. There is appropriate reference to new steel-making techniques, such as the greater use of oxygen and the growth of the Linz-Donowitz steel-making process,

experience with which is already showing a saving in capital costs per ton of capacity. In addition, the Board is at present making an inquiry into the adequacy of research in the British iron and steel industry. The result of that inquiry may well promote still further the efficient, economic and adequate supply of iron and steel under competitive conditions.

OIL ENGINE MAINTENANCE

In October, 1946, it was reported that satisfactory strip examinations had made it possible to increase the overhaul life of the Rolls-Royce "Derwent" I engine to 270 hours. Rather less than fourteen years later (actually on June 10, 1960) Rolls-Royce announced that the British Air Registration Board had approved the Rolls-Royce "Avon" Mk. 524 jet engine for 2000 hours' operation between overhauls in the "Comet 4" of the British Overseas Airways Corporation. In publishing this information it was mentioned that the "Avon" was the first commercial jet engine to reach 2000 hours between overhauls. Announcements of this kind are of special interest in days when the availability of air transport is at once affected by what appears to be quite small interruptions in maintenance service. Moreover, the cost of such service must be added not only to operating expense but to the loss incurred by deductions from the flying time of otherwise air-worthy aircraft. Particulars such as those mentioned above remind us—if indeed reminders were needed—that the scarcity of skilled maintenance men and the increasing cost of maintenance labour are matters of great importance not only to the aviation industry but to users of all types of equipment.

In a paper read recently before the Diesel Engineers And Users Association, Mr. P. F. Morgan dealt with problems affecting, in particular, users of pumping machinery, a service of outstanding industrial and domestic importance. The paper stressed, among other things, the effect of labour charges in the respective running costs of oil engine-driven and electrically-driven pumping plant. "It is," says Mr. Morgan, "the high labour charges associated with diesel plant that constitute a substantial proportion of the running costs . . . There is an optimum number of engines of a given size which can be supervised and serviced by any running and maintenance staff. Above or below this optimum the staff will be inadequate, involving extra men, or it will not be fully occupied." Diesel plant is, of course, provided in a variety of forms, and there is doubtless general agreement that "the maintenance charge will be greater for an engine running at full load for a given time at twice the running speed of another engine of the same output running for the same period also at full load." Those who, in our day, must attend to the maintenance of pumping engines, may recall—not without some envy—the account given by the late Dr. H. W. Dickinson of maintenance experience with the Cornish pumping engine at South Crofty (Robinson's shaft), where "the cylinder cover has been lifted only once or twice during its forty-eight years of working." Since the days of the Cornish pumping engine there has been a revolution not only in the demand for power but in the technology of power production. The rapidity with which one development has followed another does not lessen the need for maintenance and the evolution of methods of mass production has, concurrently with other changes, industrial and social, had a significant effect upon the supply of skilled craftsmen, notably engine fitters. The shortage of skilled men, coming at a time when the demand for power is ever increasing, has its effect on types of plant and on the means employed in dealing with the problem of maintenance. Above all, it accentuates the need for installing equipment in which a major consideration has been the provision of the highest degree of operational reliability as well as of arrangements designed to facilitate overhaul and maintenance. Dealing, in this connection, with means whereby the manufacturers of oil engines can contribute to the reduction of rising labour costs, we note that Mr. Morgan —as well as a number of speakers in the discussion on his paper—stresses the importance of trouble-free automatic starting. "It is," he says, "only by providing reliable systems of automatic starting that oil engine manufacturers can compete with rising labour costs."

On the subject of noise it is gratifying to read that research by the British Internal Combustion Engine Research Association has already disclosed procedures whereby exhaust noise and noise from fuel pumps and valve gear can be reduced. It may not be surprising to learn how investigations made by the same Research Association have confirmed that the noise made by an oil engine is directly related to its power-to-weight ratio. A commonly held opinion is that this applies also to the time interval between overhauls and it is emphatically the case that crankshaft speed must be considered not alone in its relationship to first cost but in respect also of the influence which it may have on such factors as noise and maintenance expense. Well worth quoting is the last paragraph in Mr. Morgan's reply to the informative discussion which followed the submission of his paper: "Throughout the discussion" he says, "runs the theme that to-day the oil engine faces a great challenge from electric power. To meet that challenge manufacturers must strive to reduce labour charges for supervision and maintenance, increase power output but reduce noise, and evolve a completely foolproof system of automatic starting." This certainly leaves oil engine manufacturers with a tough assignment, one, moreover, which can only be solved by close co-operation between manufacturers and users. In this connection Mr. Morgan's paper and the discussion thereon cannot fail to assist in clearing the ground.

CONSULTANTS AND OVERSEAS PORT CONSTRUCTION

One point of very general interest which was raised at the recent Institution of Civil Engineers' conference on civil engineering problems overseas was contained in the paper "Port Development Overseas: The Engineer's Place Today" by Sir Eric Millbourn, adviser to the Minister of Transport on shipping in port. Sir Eric stated that his paper attempted to show the need for a new approach to the many problems—some economic, some engineering—which were associated with the construction, particularly in overseas territories, of major port works. Towards the end of his paper he amplified one point in this matter, which we reproduce unaltered in Sir Eric's own words: "Engineers in Great Britain sometimes complain that they do not get as much overseas work as they did in the past. They suggest that, for example, the Universal Monetary Corporation always gives the jobs to Ruritanians because the Corporation has its headquarters in Ruritania and has a lot of Ruritanians on its staff. But this is not the real reason. It has already been suggested [in the original paper] that in sponsoring port plans governments have been too free with their

money. This is no longer true to the same extent of the international organisations, such as the World Bank, and the more strictly commercial undertakings which finance large capital investments. Financiers want to see a reasonable chance of the project they are financing paying its way, and having its capital serviced in an orderly fashion; even if they are benevolent and altruistic, at least they want to be sure that the project for which they are paying (and even losing) money will do the job for which it is intended. The 'speculative' port builder still needs a good deal of education to bring his feet on to firm ground in the light of this new hardening of the market against him. This education we are not yet bringing home to our clients. British engineers' reports tend to be filled with far too much admirable technical information which, frankly, the financiers do not properly understand. They are perfectly happy to take it for granted that the engineer knows his job. What they want to know is whether the job which he knows is worth doing. This fact has come to be accepted almost imperceptibly by the Americans and may well be the real reason for the welcome they get from bodies who find money for under-developed territories. For those who find money economics are far more important than the perfection of technical calculations. Finance corporations have economists on their staffs and they favour propositions where the engineer joins with the economist to produce a technically and financially viable proposition."

It is probably a very debatable point whether Sir Eric's criticism is a just one. The "hardening of the market" of which he speaks would materially reflect in less work, but in spite of this, the number of overseas ports built by British consultants in the past few years has, in our view, been very creditable. Reference to our annual supplement the "Tabular Summary of Civil Engineering Contracts" shows an impressive list of such works in progress at the moment, and several large schemes in this category have been completed in the last few years. In fact one of the stronger contributions of consultants to overseas works has been in this particular field. And as to overseas works generally, the Association of Consulting Engineers remarks, in its report for the year ended last April, that "work abroad is still at a high level".

DIP. TECH. (ENG.) PROGRESS

Not for many years yet will it be possible to assess the real value of Dip. Tech. courses at Colleges of Technology. At the moment there are only 163 holders of the award though nearly 4000 students have been enrolled. The final prestige which the award will acquire must depend upon the relative success or failure of those 4000, and many more thousands to follow, after they have taken up work in industry. What can be said now is that to judge from the annual report of the National Council for Technological Awards issued a week ago the scheme has got off to a very good start. Colleges have proved eager to have courses approved and students have been enrolled in satisfactory numbers. There are now 95 recognised courses at 23 colleges leading to the award. The number of students in the first year of these courses is now 1558 as compared with 1171 last year. Of the 95 courses 53 lead to the acquirement of the Dip. Tech. (Eng.). It is interesting and good to see that though the majority of these engineering courses are straightforwardly in civil, mechanical, or electrical engineering there are also courses in aeronautical engineering, chemical engineering, production engineering and production technology. In addition one of them is in naval architecture. But there is one defect, noticeable in the previous report, which persists. Though in other areas of the country there seem to be adequate numbers of courses offered by a reasonable number of colleges quite well dispersed, on the North-East Coast Sunderland Technical College is alone in offering courses and only civil engineering and naval architecture are covered.

From next year onwards the National Council for Technical Awards will be considering the renewal of the recognition of existing courses. From the beginning the Council conceived courses leading to the Diploma to be a complete entity; that is it considered the industrial training to be just as much part of a course as the academic study. Indeed it is this close connection of practical training with academic studies which particularly distinguishes Diploma courses from those at universities leading to the Honours degree. Recently the Council has been reviewing the question of industrial training and it has decided that in future the arrangements for industrial training in new courses submitted for initial recognition will be examined in more detail than before. It has therefore circulated a Memorandum which it believes will be helpful to colleges and to industry about this matter. A sentence of some importance to engineering firms is worth quotation. "Where firms are already operating schemes of industrial training which have been approved by professional institutions, the main problem of the firm and the college will be to explore the correlation of the industrial training with the academic study and the Council expect that schemes of industrial training will be modified if experience shows this to be desirable." One of the by-products of the Diploma scheme is that closer collaboration between industrial firms and colleges is being encouraged. We know of certain firms and colleges which have for long been thus closely inter-linked. Judging from what they tell us of their experiences there can be no doubt of the value of such close contacts.

The Engineer—100 Years Ago (JUNE 29, 1860)

"A RAILWAY ACROSS THE CHANNEL"

"Another Frenchman, M. Gustave Robert—and certainly for downright thorough-going chimeras few can equal the French—has ventilated his ideas on this subject. *Galignari* says :—'Without entering into any consideration of the merits of this plan, which, it is not too much to say, no one living will ever see realised, we give an outline of the author's views.' M. Robert remarks that the breadth of the Channel is 32,000 mètres (20 miles) ; its greatest depth 57 mètres, and its average depth 32 mètres. The jetty which he proposes is to rest on a colossal foundation, 10 mètres below the level of the sea, having a breadth of 154 mètres at its base, and of 88 mètres at its upper surface, and on an average altitude of 22 mètres. On this foundation rests the jetty, its crest above water measuring 28 mètres across, and its base 76 mètres, with an altitude of 16 mètres from the foundation, so that it stands 6 mètres out of the water. Four double lines of rail are laid down along the crest ; any danger of a train's slipping off the rails into the sea is obviated by two strong lateral walls, each 3 mètres in thickness. Two passages are to be left for ships, with ports of refuge on each side, to enable them to wait in safety until the trains have passed, and the swing-bridges spanning the passages have been opened. These passages and ports of refuge are to be declared neutral, so as to secure the navigation of the Channel at any time to all nations. As both the coasts of France and England consist of high cliffs, offering the greatest convenience for the establishment of quarries, the materials for the construction of the jetty are to be had in abundance and cheap. The cost of such an immense undertaking is calculated at 4,200 millions of francs.

Some Structural Engineering Advances

*The sixth congress of the International Association for Bridge and Structural Engineering has been in progress in Stockholm this week. The "preliminary publication" of the congress contains five groups of papers dealing with basic (i.e. theoretical) subjects and one group in which some important new structures are discussed. The ensuing abstract is taken from the general report of this last group, illustrated by diagrams from two of the papers themselves. The general reporter is Mr. O. A. Kerensky.**

THE eight papers accepted deal with atomic power stations, dams, bridges, plate girders, composite construction, and battle decks; they have little in common except that all describe new constructional features. It is, therefore, impossible to make a proper appreciation of the latest developments in the fields covered by them. Instead, the report gives reasonably comprehensive summaries, underlining important features in each paper, and suggests subjects for discussion.

The two papers by Professor Kurt Billig are complementary and give some factual data for, and a general appreciation of, the factors affecting design and construction of the nuclear power stations, with particular reference to the civil and structural engineering problems associated with the nuclear reactor. The author gives a considerable amount of statistical data relating to six nuclear stations constructed, or under construction, in Great Britain.

Although the gravity loads in nuclear structures are considerable, the most important problems arise from temperature changes, creep, shrinkage, and variations in moisture content of the concrete. The raft has to withstand gravity loads and temperature stresses, together with moments and shears due to the fixity of the shield walls. It is imperative that differential settlements between units of plant are kept to a minimum.

By siting reactors underground advantage can probably be obtained from the point of view of containment as well as appearance and protection in war. At Halden in Norway it has been found that there is little difference in cost between a conventional reactor building and an underground containment.

Due to irradiation most metals become hardened, and limited experiments have shown a slight decrease in creep strength. In soft metals the yield stress is raised, whilst ductility is reduced. Neutron irradiation, in general, tends to raise the transition temperature of a metal, thus rendering it more liable to brittle fracture. Research is being carried out on embrittlement of mild steel under prolonged strong irradiation. Many of the effects of irradiation on metals can be reduced or removed by annealing.

In the case of concrete, radiation damage is not too serious. Tests on concrete specimens carried out at Harwell lead Professor Billig to believe that it is unlikely that there will be any significant change in the properties of concrete in shields already built during the operational life of the reactors.

The author briefly describes a prestressed concrete pressure vessel used for the reactor at Marcoule where the concrete also acts as a shield, gas tightness being assured by lining the vessel with sheet steel which acted as formwork during the casting.

Considering the practical aspects of concrete construction the author states that certain forms of cracking do not reduce the effectiveness of concrete as a shield, and, in addition, suggests that in the past specifications have been too stringent in respect of uniformity of density of shield concrete.

It appears that experimental evidence is lacking in support of many assumptions used in shield analysis, but measuring instruments are now being included in the shields under construction. At Hinkley Point this work is being supplemented by a comprehensive investigation of the site concrete.

A Prestressed Arch Dam

In the paper on "Le barrage de Tourtemagne en Valais (Suisse)," Professor F. Panchaud describes the application of prestressing adopted in the construction of a 30m high thin arch dam which retains the glacier waters in the 850,000 cubic metres capacity reservoir. Various details of the structure are shown in the accompanying diagram, which have been taken from Monsieur Panchaud's paper.

The necessity for prestressing was mainly due to three factors:

(1) The decision to use a thin structure.

(2) The location of the dam in an area subject to severe climatic conditions.

(3) The function of the reservoir which involves it being emptied and filled at all seasons with glacial water.

The dam closes a narrow gorge and is composed of a thin vertical cylindrical arch 1·20m thick and with a maximum height of 28·5m resting on a pedestal of concrete built into the bottom of the gorge. At the level of the coping, the length of the structure is about 115m. On the right bank the arch is prolonged by a rectilinear wall of no great height forming a gravity dam about 30m long. Thus the developed length of the arch portion of the dam is 85m. The directrix of this arch is formed by a series of segmental arches whose radii increase from the crown to the springings from 20m to 50m. A gallery 1·20m wide, located on the foundation rock, runs around the periphery of the dam embedment.

When the lake is empty only thrusts due to thermal effects are developed in the arch.

A network of vertical cables starting from the coping and ending in the gallery at the foot of the dam compress the horizontal sections of the vault and assist in combating the bending forces. The trace of the cables in each vertical section was chosen so that no tension appears in these sections however full the lake may be.

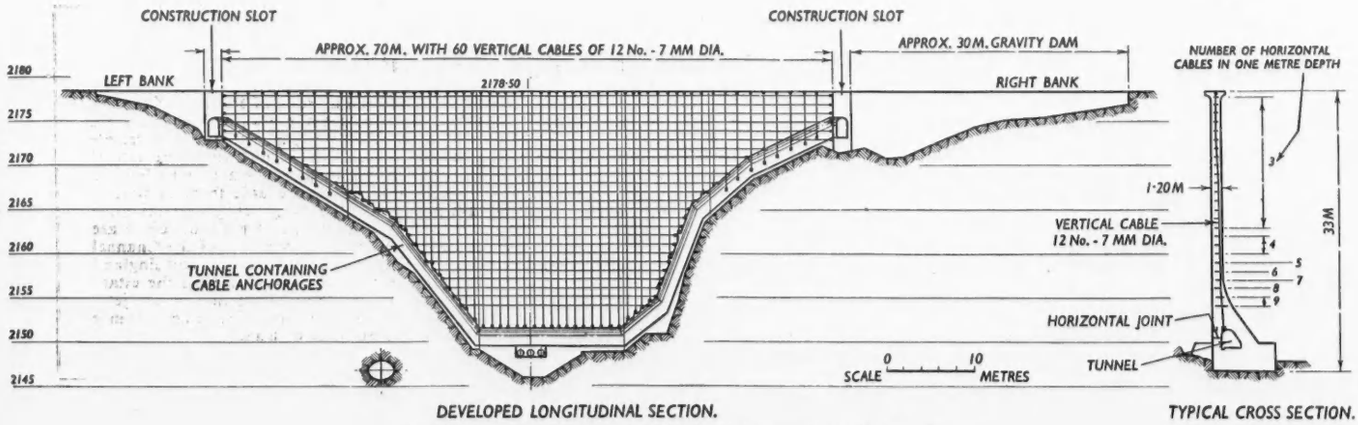
The horizontal prestressing was obtained by means of curved horizontal cables following the form of the arches and ending in the galleries at the abutment in each bank. The cables were supplied with sheaths and placed on the horizontal concrete construction joints at 1m centres.

Four vertical temporary expansion joints were provided starting from the foundations and dividing the vault of the dam into five voussoirs of 15m and 17m long. Moreover, in the neighbourhood of the coping two construction slots were left open which will only be closed after the prestressing has been completed and after a cold season.

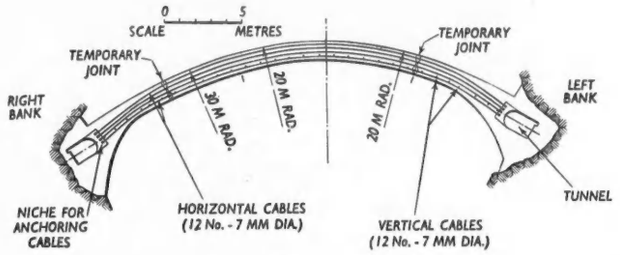
The expansion joints were provided with Freyssinet flat jacks of 42cm diameter which enable the shortening of the voussoirs, due to the prestressing, to be compensated for by opening the expansion joints proportionally, thus maintaining the horizontal prestressing force. The force exerted by the jacks at each level was chosen to be slightly above that produced in the same section by the horizontal cables, so that at the springings a permanent compression is opposed to all forces which would uproot the foundation.

The author claims that the construction of the Tourtemagne dam is the first application of prestressing to thin arch dams.

* Partner, Messrs. Freeman, Fox and Partners.



Details of the Tourtemagne dam in the Valais province of Switzerland



Tourtemagne dam : cables at level 2160

For combating the tensions due to intense thermal effects the solution adopted is technically more satisfactory than that which consists of strengthening the sections by passive reinforcement. Prestressing cables and flat jacks have been used in other dams to assist in resisting the primary forces due to impounded water, but this dam employs a unique combination of prestressing cables and flat jacks to resist the secondary stresses due to temperature changes.

Prestressing cables were used to keep the arch homogeneous and watertight by neutralising tensile stresses due to thermal action and to control stresses due to boundary effects adjacent to foundations. Flat jacks inserted in expansion joints were used to : (*a*) Maintain the geometric shape of the structure by " taking up " the shortening of the concrete due to horizontal prestressing and thus eliminating unwanted secondary effects of the prestressing. (*b*) Push the sides of the dam into the rock abutments. (*c*) Enable the expansion joints to be kept open until the best closure temperature of the dam was reached.

The author does not state how the actual construction worked out in practice and whether the scheme proved economical.

Glen Canyon Bridge

The paper by Mr. Robert Sailer describes the Colorado River bridge, completed in February, 1959. The bridge is spectacular in appearance, crossing Glen Canyon 700ft above water level with a single span of 1028ft. It is the highest arch bridge in the world and the second longest of its type in the U.S.A., but it incorporates few new features which call for discussion. (See illustrations overleaf.)

The bridge is designed to A.A.S.H.O. Specification to carry two lanes of H.20–S.16 loading on the 30ft wide roadway. Wind load was taken as 75 lb per square foot without live load, and 25 lb per square foot with live load. A temperature range of ±60 deg. Fah. was adopted.

Studies were made of fixed, two-hinged, and three-hinged arches, and, in the case of the fixed arches, solid ribs were compared with trussed ribs. Although somewhat less economical, trussed ribs were preferred as they were less flexible and subject to smaller wind loads. The two- and three-hinged arches were both about 14 per cent lighter than the considered fixed arch. Finally, a two-hinge trussed arch was selected.

The deck system consists of a 6in r.c. roadway slab (4in footway) on continuous wide flange beam stringers. But it is not clear whether composite action has been considered.

At the crown the floor beams (cross girders) rest directly on the ribs and the floor system is held longitudinally at this point. In order to reduce secondary stresses due to interaction of floor system and ribs, disc bearings allowing rotation longitudinally and transversely are used for these floor beams and also for the columns supporting the floor beams over the central portion of the arch. The longer columns have riveted connections.

Horizontal wind bracing is provided between abutments and panel point 12 primarily for wind stresses during erection, the slab being effective for transverse winds in the final structure.

Field connections of trusses and bracing are riveted, and those of columns and floor are bolted with high-tensile bolts—presumably grip bolts.

The 10ft wide concrete skewbacks are set 16ft into the sandstone and are designed so that under service conditions tension never occurs at the backface but anchor rods are provided to cater for any tensile forces which might occur during erection.

The bridge was erected by the cantilever method with two sets of tie-back cables, using a 25-ton capacity cableway spanning 1540ft. An auxiliary cableway for personnel was also installed. The cables were moved forward panel by panel as erection proceeded, as far as panel point 15, the final 130ft of each side being cantilevered out.

The arch was closed on 20in diameter steel pins in the upper chords, the tie-back cables were then slackened off. The erection of the floor system proceeded from the centre outwards. The whole of the steelwork was erected in seven months.

The concrete deck was completed in twelve days using metal forms, which were left in place. To avoid overstressing the centre section of deck was placed first, followed by the end sections and finally the sections above the quarter points.

Tancarville Bridge

In his paper on the Tancarville bridge,† Mr. A. Delcamp briefly describes the main features of the bridge, which was opened to traffic in July, 1959, and discusses several novel features of design and especially the solution of the aerodynamic problem. The designers and constructors of the bridge have shown originality in conception and adopted most modern techniques in reinforced concrete, prestressed concrete and steel construction. The bridge and approach viaducts carry a 40ft roadway and two 4ft footways. The suspension bridge has a central span of 1995ft and two side spans of 577ft with a clearance for shipping of 167ft. The approach viaduct on the left bank consists of eight spans of 164ft each, constructed in prestressed concrete.

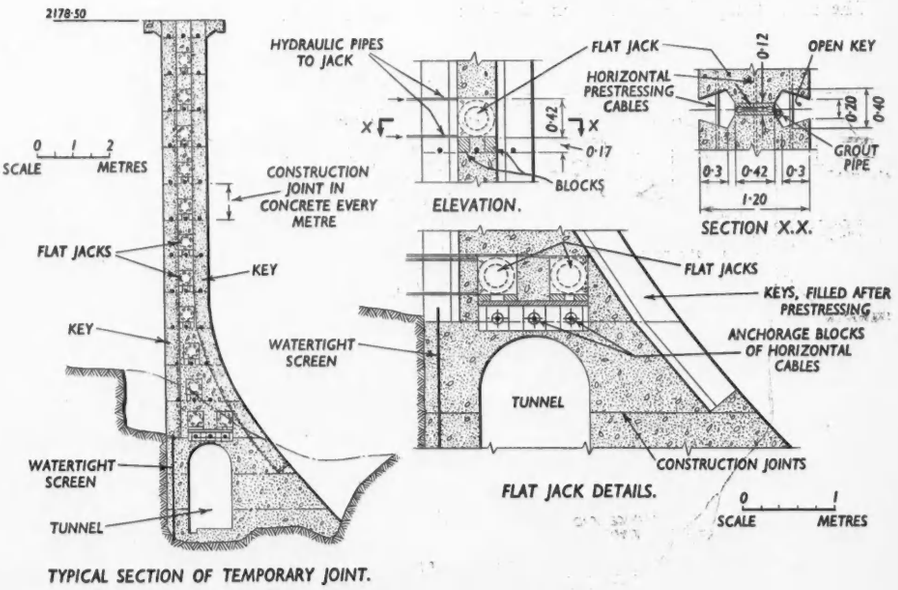
The left bank anchorage is a gravity one consisting essentially of two walls, in line with the bridge cable, supported on caissons founded on a bed of sand and gravel. The walls are joined at the back by a reinforced concrete box containing ballast, and are capable of slight articulation at their junction with the caissons. In view of the difficult ground conditions the designers are to be congratulated on having evolved a relatively economic anchorage.

The right bank anchorage consists of two separate 160ft long prestressed concrete tunnel anchorages in the calcareous rock.

The towers are constructed in reinforced concrete and, at 390ft, are by far the tallest concrete towers yet built.

It is in the design of the suspended structure that the biggest departure has been made from previous practice in long span suspension bridges. Since the failure from wind oscillation of the first Tacoma Narrows bridge in 1940, American and British designers have kept the conventionally flexible features of suspension bridge design and directed their efforts towards producing a cross section which was aerodynamically stable. In contrast with this the designers of the Tancarville bridge, whilst keeping the open web stiffening truss, which is the most important feature of an aerodynamically stable cross section, have done all they could to stiffen their suspension system. This has been done by interconnecting systems which

† See also The Engineer, Aug. 14 1959, page 82.



Details of vertical temporary joints in Tourtemagne dam

in most previous designs have been independent. The side span and main span trusses have been made continuous at the towers, the deck has been made to act integrally with the top chord of the stiffening truss, the two trusses have been braced to form a torsion box and the cables have been clamped to the tops of the stiffening trusses at the centre of the main span to prevent relative longitudinal movement. These measures greatly complicated the analysis of the structure, as it increased the number of static indeterminances from 1 to 4.

It is a pity that the account of the aerodynamic tests is incomplete and rather confused. The ignoring of the effects of symmetrical oscillations seems to require further justification.

Asphalt Surfaces for the Forth and Severn Bridges

Messrs. Trott and Wilson's paper describes tests carried out over a period of eight years to find a suitable form of asphalt surfacing for the decks of Severn and Forth suspension bridges. All the test panels were laid in a heavily trafficked road and some have now been in service for six years. A 12½-ton test load was applied to each panel and no cracks appeared in the asphalt. The authors also investigated the contribution of the asphalt surfacing to the rigidity of the deck plates ; it was found that there was very little contribution at summer temperatures, but under winter conditions the 1½in asphalt increased by about 80 per cent the rigidity of the steel decking.

In the first experiment four steel panels ½in thick were set in the roadway and surfaced with mastic asphalt. Three of the panels were smooth and had different thicknesses of asphalt : 1in, 1½in and 2in, the fourth panel had a chequered pattern and 1½in of asphalt. The steel panels had previously been sand blasted and coated with bituminous paint. During the first year of service the bond failed at the edges of the panels, and rust had penetrated 7in from the edge. Over the next four years cracks appeared in the asphalt over the deck stiffeners, penetrating the 1in asphalt right through to the steel deck, but in the case of the 1½in asphalt the cracks appeared only in the surface. Apparently there was no evidence of the asphalt pushing on either the smooth or chequered panels except where the bond failed at the edges.

The second experiment commenced when the first two panels were removed and replaced by a new larger panel consisting of three steel plates of different thickness, ½in, $\frac{9}{16}$in and ⅝in, welded together. The panel was sprayed with 0·002in of zinc to gain improved protection from corrosion, and then treated with bituminous paint. Half of the panel was surfaced with 1½in of stone-filled mastic asphalt and the other half with 1⅛in of stone-filled mastic on ⅜in of damp-proofing mastic. The ⅜in mastic was returned into an angle welded to the edges of the panel. The edges of the 1½in asphalt being sealed against the edge angles by a rubber-bitumen compound. Apparently there was little difference between the condition of the asphalt on the ½in, $\frac{9}{16}$in and ⅝in deck panels after 5½ years of service, but there was some corrosion at the edge joint between the angle and the two course mastic. The rubber-bitumen joint was found to be entirely successful.

Tests on Girders with Slender Webs

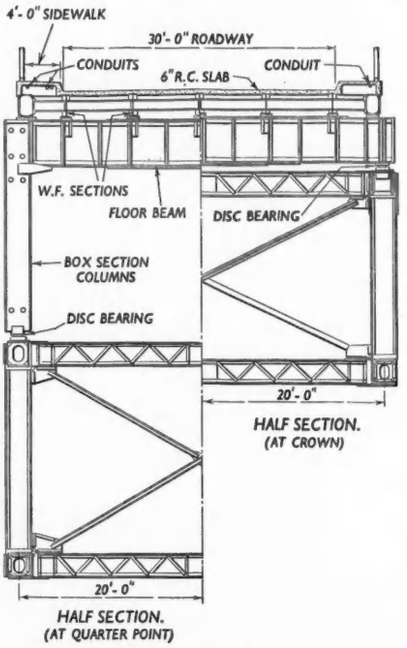
Messrs. Basler and Thurlimann of Lehigh University give and discuss results of fifteen tests on seven full-size welded mild steel plate girders. The paper makes an important contribution to the factual data on which the design of slender webs should be based. Girders with webs of slenderness ratio of 185 and 388 were tested in bending and with ratio of 255 and 259 in shear, with vertical stiffeners spaced apart at ½, ¾ and 1½ times depth of web. No horizontal stiffeners were used. The tests show yet once again that the web critical loads in bending or shear have no real significance in assessing the actual load-carrying capacity of slender plate girders.

The authors do not attempt to develop a new design method, but in discussing the results they conclude that the classical critical load theory based on an elastic behaviour of a perfect web is unable to predict the carrying capacity of girders subject to shear or moment. They assert that a panel of web should not be considered as an isolated element, but that it is of the utmost importance to investigate the strength of the supporting frame, consisting of the flanges and the transverse stiffeners.

As far as your reporter knows, of all modern specifications only the British Standard (B.S. 153) published in 1958 takes into account the post-buckling strength of effectively stiffened webs and further study of the strength of plate girders about to be undertaken by Lehigh University should be welcomed by all concerned with the economic design of deep plate girders.

Composite Construction in the U.S.S.R.

Professor Gibschmann describes the use of precast reinforced concrete units in composite action construction in the U.S.S.R. He states that combined action construction

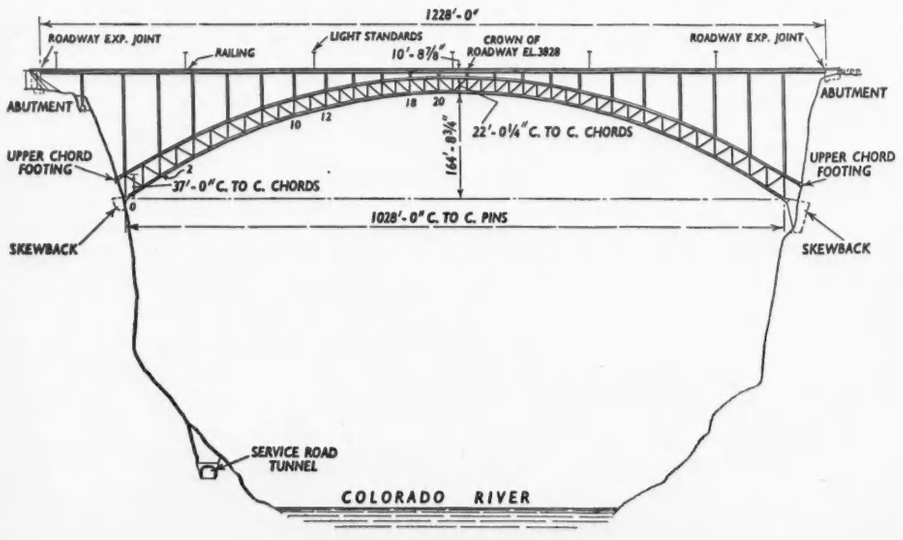


Details of Glen Canyon Bridge

is considered to be very economical and is much used. To expedite construction, particularly in the winter, and to reduce shrinkage and creep effects, the r.c. slab is often made up of precast units. Many large span bridges have already been built using this form of construction, notable among them being the three-span continuous girder bridge in Moscow with spans of 72·6m, 108m and 72·6m. A further and novel development is the provision of a precast concrete bottom flange in the compression zone of continuous girders. The precast units are attached to the supporting girders either by steel shear connectors which are welded to the steel flanges and concreted *in situ* into the specially provided holes or grooves in the precast units or by steel lugs or plates cast into the precast units and welded on site to the sides of the steel flanges.

The edges of grooves or holes formed in the precast units must be castellated to ensure a good bond between the *in situ* concrete filling and the precast units. A great deal of research has been carried out in the U.S.S.R. on the behaviour of composite decks and, in particular, on the design of shear connectors. The best type of connector was found to be of the rigid dowel type with oblique tying-in rods welded to it. It was found that the anchoring of the concrete to the flange against vertical uplifts improves the carrying capacity of the composite unit. These findings seem to be in agreement with the German ones. When welding the cast-in connectors to the steel girders, care must be taken not to damage the concrete by the heat from the arc and by the changes in length of the steel elements. To eliminate both these dangers the distance of the weld from the concrete must be appreciable and the welds as thin as possible.

Tests on a complete bridge show that precast concrete combined action deck behaves very similarly to the cast *in situ* one.



Colorado River Bridge at Glen Canyon

Large Electricity Supply Systems

C.I.G.R.E. MEETING IN PARIS

No. II—(*Continued from page* 1041, *June* 24)

The eighteenth convention of the International Conference on Large Electric Systems (C.I.G.R.E.) was held in Paris, from June 15 *to* 25. *It was concerned with technical, rather than economic aspects of electrical power systems. The subjects discussed at this convention were power system planning and operation, insulators, lightning and surges, direct current, high-voltage cables, extra-high-voltages, transformers, overhead lines and towers, generators, relaying and circuit breakers. Below we give a short résumé of the session covering high-voltage direct-current transmission of power.*

DIRECT-CURRENT transmission at extra high voltages is discussed at alternate C.I.G.R.E. conventions, that is, every four years. In the interim period technical progress is kept under review by a Study Committee. This committee issued a progress report (No. 418) at the 1958 convention to cover the period since the previous convention, 1956, when the subject of d.c. transmission had been discussed in full session. Since this report was published the committee has met in Paris and twice in Berlin when the topics of phase compensation and control systems for d.c. transmission were added to the agenda.

At the recent convention six papers or reports were presented for discussion on June 17. Two of these reports (414)[1] and (415)[2] were of a general nature and were concerned with d.c. transmission schemes either in operation or projected. More specialised aspects of the subject were dealt with in the other reports (403[3], 404[4], 411[5], and 417[6]).

There are two d.c. transmission schemes in commercial operation : the older one involves a submarine cable link between the island of Gotland and the Swedish mainland ; the newer one uses an overhead transmission line to link Kashira and Moscow. Two other d.c. transmission schemes are under construction : one, for 750MW, will link the Stalingrad and Donbass networks at 800kV, d.c. ; the other, across the English Channel will connect the systems of Electricité de France and the Central Electricity Generating Board in Great Britain and will be designed to transmit 160MW at 200kV. Other schemes are under consideration in Italy, Canada, Venezuela (where the project envisaged is a connection between two systems having two different operating frequencies).

Progress in high-voltage transmission techniques depends on the setting up of experimental centres where development and testing can proceed under controlled conditions. There are installations of this kind in Sweden and the U.S.S.R., Great Britain, Japan and elsewhere. Laboratory reports from Sweden and Great Britain contributed three reports for discussion at C.I.G.R.E. One, (No. 403)[3] gave a comparison between d.c. and a.c. insulators. The second (No. 404)[4] described the representation of an h.v., d.c. link in a network analyser. The third (No. 411)[5] described radio-interference measurements carried out in Sweden with a view to determining the extent of any precautions to be taken at the British terminal of the cross-Channel d.c. cable. This paper also gave information on the design of a screened building for converter plant and discussed measurements already done on a small trial building of similar construction.

Details of a new research project in the U.S.A., devoted, initially to a.c. problems, was described in report No. 406[7] where reference was made to possible work on high-voltage direct current in the future.

In the discussion (under the chairmanship of F. J. Lane) two speakers gave some information about operational experience on the two d.c. transmission schemes in existence. Referring to the Gotland d.c. cable link, which has been in operation about five years, G. von Geiger (Sweden) said that after the few early teething troubles—referred to at previous C.I.G.R.E. meetings—operation had been very satisfactory. During the last two years the system had given 92 per cent availability. The number of faults that occurred on the d.c. side had been reduced from fifteen per year, to one last year.

M. P. Kostenko (U.S.S.R.) spoke of experience with the 112 km overhead line transmitting 30MW, d.c. between Moscow and Kashira. Experimental operation of this link over 4½ years indicated that the original arrangement of three valves in series was unsatisfactory ; parallel connection was, therefore, adopted. In the early days the main fault was found to be switching failure on the valves. A system for reducing r.f. interference was worked out. Damping circuits were introduced to eliminate the trouble caused by surge voltages.

P. Laurent (France) dealt with some of the economic aspects of the Channel cable link and the choice of direct current for this transmission. Although detailed design studies indicated that the cost of the conversion equipment would be more than originally estimated, the d.c. scheme would still be preferable to the a.c. scheme envisaged originally.

M. Stalewski (Great Britain) gave details of the new experimental station which is being equipped for studies by the C.E.G.B. of problems on h.v. d.c. transmission. It will use British equipment, including mercury-arc valves developed for such transmission. This project will be sited in a disused part of Acton Lane power station, where there are four obsolete turbo-alternator sets that can be used as synchronous condensers with a total reactive capacity of about 100MVAR. The experimental transmission system will have a capacity of about 63MW, 70kV, 900A, based on single-anode valves with an anode mean current rating of 300A. The kind of work for which the system will be used is the determination of the characteristics of mercury-pool valves and other comparable devices, back-to-back operation and the setting up of appropriate ratings.

Professor A. Asta (Italy) described a proposal to set up experiments on a miniature d.c. model network in an Italian university with a view to studying the possibilities of submarine cable links.

Details of research and development work done in Swedish laboratories during the last four years were given by Dr. U. Lamm (Sweden). A valve under development had been tested up to 125kV and it was felt that the design could readily be extropolated up to 150kV. For the current rating required of the cross-Channel converters (800A) four-anode valves would be used, compared with the Russian trend towards single-anode valves of high rating. Describing the development of valves in Sweden Dr. Lamm showed slides illustrating the manufacture of some of the equipments for the cross-Channel link. He mentioned comparative studies that were being made of the use of static capacitors instead of synchronous condensers for supplying reactive KVA and stated that the former would be used in the cross-Channel scheme.

Converter Connections.—In an appendix to the report (417)[6] of the study committee on d.c. transmission, Dr. Lamm had proposed, in relation to the six-pulse bridge connection, that the voltage of a valve should be defined as the voltage between the d.c. terminals of a group of six such valves operating at full load (assumed to be 13 per cent lower than the no-load voltage at zero delay angle). During the discussion Dr. T. E. Calverley (English Electric Company, Great Britain) suggested that it would be more logical to define the valve group voltage as the no-load voltage, rather than the full-load voltage. He agreed that the three-pulse single-way short-circuit test described by Dr. Lamm was satisfactory but pointed out that other tests would be useful for demonstration of valve performance.

Insulators and Overhead Lines.—Four of the reports discussed were concerned with insulators, overhead lines, overvoltages, corona, and testing.

A very full investigation comparing d.c. and a.c. insulators with preliminary recommendations for the insulation levels and leakage distances of d.c. transmission lines was given in report No. 403[3] by H. Witt (A.S.E.A., Sweden). These recommendations were influenced by the fact that switching and other internal overvoltages are comparatively rare. The report described rain, fog and pollution tests under laboratory conditions. There are three main conclusions. First, that the insulation of a d.c. transmission can be determined primarily by the normal service voltage under unfavourable climatic conditions ; this means that the leakage distance will be the main factor in the design. Secondly, that, under polluted air conditions, the d.c. flashover voltage of an insulator appears to be about equal to the a.c. flashover voltage ; therefore a given service voltage to earth requires the same leakage distance for a.c. and d.c., namely, 5cm to 7cm per kilovolt. Thirdly, under clean air conditions a leakage distance of 2cm per kilovolt to earth could be used. As Mr. Witt indicated during the discussion of the reports a reduction from 2cm to 1·6cm per kilovolt could be envisaged for the leakage path.

Overvoltages, insulation, protection and testing of the Stalingrad-Donbass terminal equipment and overhead lines were dealt with in Report No. 414[1]. In the Stalingrad-Donbass scheme the d.c. transmission voltage of ±400kV is obtained by eight series-connected valve bridge circuits of 100kV each. Each bridge consists of twelve working valves and two by-pass valves, all of which are identical single-anode units, with sectionalised anode blocks, external voltage dividers, pumping systems and oil cooling. The 475 km transmission line and the equipment in the converter stations will be protected

against overvoltages by multiple spark gap arresters.

Insulation problems at the English and French terminal stations of the Channel cable link were dealt with in part of Report No. 415[2]. According to this report tests under conditions of salt pollution and high humidity have been disappointing and indicated the need for leakage paths of 2in per kilovolt instead of 1·3in per kilovolt as established for a.c. transmission. In this particular scheme, however, the French converter station is about 5 km inland and the insulation has not been specially increased ; but the English converter station is about 2·5 km on a more exposed coast and the leakage path length adopted is 1·5in to 1·6in per kilovolt because some amount of salt pollution is to be expected.

In the discussion of this group of papers a communication from Madame A. A. Vinogradova (U.S.S.R.) gave some figures for insulation distances under clean-air and polluted conditions in Russia. For areas of polluted air the insulators were designed to have leakage paths of 2·2cm per kilovolt to earth and the insulators were cleaned twice a year.

Dr. J. S. Forrest (Central Electricity Research Laboratories, Leatherhead) referred to tests carried out in England over a period of three years under different natural conditions at three centres : Leatherhead (clean air) ; Croydon (industrial) ; and Brighton (salt air). Tests had been made at voltages up to 100kV to earth, with positive and negative polarities, on various types of insulators, including normal cap-and-pin, anti-fog cap-and-pin, post insulators and bushings. First conclusions from these tests were that d.c. leakage current surge phenomena were similar to those pertaining to a.c., but that the d.c. conditions were slightly more severe. A leakage path value of 4cm to 5cm per kilovolt (about 30 per cent more than for a.c. insulators) was indicated. The application of grease gave an improvement on a.c. as well as d.c. insulators.

Radio Interference, Harmonics and Filters.—Radio interference problems were considered in Report No. 411[5], which gave details of test measurements made at the Gotland terminal station, related them to the prospective interference expected at the English terminal of the Channel cable, and suggested remedial measures.

According to this report adequate interference suppression can be applied to the largest converter plants provided that the requirements of screening and filtering are allowed for at the earliest planning stage. These measures may add 50 per cent to the cost of a conventional building. For the converter plant building at Lydd on the Channel cable scheme there has been developed a form of building construction which incorporates screening properties. This building, which has a volume of about 378,000 cubic feet is expected to cost about £90,000, that is, about 40 per cent more than that of a conventional building.

Discussing the origin of r.f. interference from converting plant, and possible methods of reducing such interference Mr. R. E. Martin (Central Electricity Research Laboratories, Leatherhead) pointed out that the amplitudes of medium frequencies could be controlled reasonably by damping systems but that at higher frequencies the task was more difficult because the physical dimensions of the equipment might be several quarter wavelengths. He went on to describe a high-frequency current-transformer for measuring stray currents (3mA to 1A at 100 kc/s to 200 Mc/s) and he mentioned the use of ferrite rings to offer high impedance to h.f. interference currents in busbars.

Performance Calculations and Control Problems.—A method of representing a high-voltage d.c. link by a network analyser was described in Report No. 404[4]. The method was described as being suitable for the study of behaviour of d.c. links for normal conditions, for symmetrical faults in the a.c. networks and for faults in the d.c. transmission.

In this discussion Mr. L. F. Norlin (Swedish State Power Board) recounted some of his experiences using Dr. Uhlmanns method on a network analyser. He maintained that, for stability calculations, these methods were somewhat time-consuming. In such cases, according to Mr. D. G. Taylor, (English Electric Company, Ltd.) the digital computer could be applied with advantage.

One of the questions that arose for discussion was whether it was possible to design completely new control schemes by purely analytical means, starting with a knowledge of the transient characteristics of the individual elements. Mr. C. Adamson (Manchester College of Science and Technology) asserted that it was not generally possible to design control schemes by analytical means. Dealing with the use of semiconductor devices for protective and control duties he gave details of some life tests carried out on transistors : the results had been very encouraging.

Cables and Earth Return Effects.—Mechanical problems of handling, laying, jointing and recovering sea cables were dealt with in Report No. 415[2]. Corrosion problems arising from high-voltage d.c. transmission with earth return were examined in an appendix by J. H. Gosden to Report No. 417[6], the conclusion being that there are no difficulties in the case of an electrode acting as a cathode, and that for anodes various corrosion-resistant materials are readily available.

On the subject of submarine cables Dr. Gazzana Priaroggia (Research Laboratories, Pirelli, Milan) discussed some of the electrical and mechanical problems that had to be faced when the cables were to be laid at considerable depths. He believed that cable makers and users were still at the beginning of the art and that there was yet no ideal type of cable for d.c. submarine crossings. Whether plastics or more conventional dielectrics would provide the best solution was not yet decided. He emphasised the importance of anti-twist armouring. Finally, he referred to a projected installation for the life-testing of submarine cables in Italy.

Dr. Rusck (A.S.E.A., Sweden) described some Swedish investigations into the effects of d.c. cable currents on ships' compasses. He said that the course corrections required were small compared with those needed to allow for winds and tides.

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(To be continued)

Technical Reports

The Internal Damping due to Structural Joints and Techniques for General Damping Measurement. By D. J. Mead. A.R.C. Current Paper No. 452. H.M. Stationery Office. Price 6s.—This paper discusses in qualitative terms the source of damping in riveted or bolted joints which are subjected to harmonically varying loads. Owing to the complicated nature of the source, an analytical determination of the damping properties of a joint is not deemed feasible, but from characteristics of the joint which may be obtained experimentally, a method is suggested of predicting the structural damping coefficient of a simple structure, vibrating in a known mode and at a known frequency.

Several techniques for the measurement of structural damping are described, and their applicability to different cases is considered. Some new methods are suggested, which will be of use in a specialised programme of research into joint damping.

Three of the methods have been used in an experiment to determine the damping properties of simple joints in the bending flanges of a vibrating box beam. Over the limited range of load amplitude covered in the experiments, the energy loss in the joints at about 40 c./s. was found to be proportional to the joint load raised to the power of approximately 2·7. This energy loss was found to vary almost in proportion to the frequency of the oscillating load on the joint, but the possible errors involved in changing the frequency throw doubt on this result. Suggestions are made for the reduction of these errors.

Of the methods of damping measurement described and used, the most satisfactory is considered to be the method of measuring the energy input into the structure to maintain steady vibration. This method is least susceptible to errors due to harmonic distortion, may be used on systems with non-linear damping and gives results more quickly and accurately than the other methods.

Problèmes de la Surface Portante Annulaire Traités par la Méthode des Analogies Rhéoélectriques. By Gérard Hacques. Publications Scientifiques et Techniques du Ministère de l'Air, No. 358. Paris : Magasin C.T.O. : 2, Avenue de la Porte-d'Issy, Paris (15e). Price 27.00 N.F.—During the last few years, attention has been drawn to the annular wing form by Sborowski's proposal of the "Coléoptère" vertical take-off aircraft. Very little however, has been published on the aerodynamics of such wings, other than the results of some wind tunnel tests carried out by N.A.C.A., and a theoretical paper by J. Weissinger. The present investigation by Dr. Hacques therefore in many ways breaks entirely new ground. The author uses the electrolytic tank method which gives solutions which apply to a perfect, incompressible fluid. The transition to compressible fluids is then made in accordance with the Prandtl-Glauert theory. The investigation covers two principal regions, according to whether the diameter/chord ratio is greater or less than three. In the former case the linear aerofoil theory may be applied, while the second region can be treated by an extension of the linearised wing theory. For an annular wing subjected to axial flow the author investigates the effects of conical shape of the wing and of wing curvature. A further chapter is devoted to the effects of incidence other than zero, with or without the presence of a central fuselage. A study is also made of the behaviour of an annular wing fitted with an airscrew. Finally, the author discusses the representations of the stream function by means of the electrolytic analogy.

The Rotating Flap as a High-Lift Device. By L. F. Crabtree. A.R.C. Current Paper No. 480. H.M. Stationery Office. Price 4s.—It is well known that a wing in an airstream can develop extremely high values of lift coefficient if it is rotated about a spanwise axis. A more practical development of this system is a fixed mainplane with a rotating trailing-edge flap. The results of some little-known German research on both systems have been collected together and are presented in compact form together with some further analysis. The emphasis is on the wing-rotating flap combination, and it is shown that this is a very attractive way of generating high lift. Some gaps in the knowledge of the device are pointed out, and suggestions are made for some further research.

The Analogy Between the Bubbling of Air Into Water and Nucleate Boiling at Saturation Temperature. By G. B. Wallis, U.K.A.E.A. Research Group, Winfrith. H.M. Stationery Office. Price 3s.—This report presents a case for the separate consideration of the hydrodynamic and thermal spects of nucleate boiling. It is shown how boiling phenomena may be simulated in detail by the use of porous media to introduce air bubbles into water. Points of similarity and equivalence are described and analysed.

International Machine Tool Exhibition

No. II—(*Continued from page* 1057, *June 24*)

IN this article we continue our descriptions of some of the machines and equipment to be seen at the International Machine Tool Exhibition which opened at Olympia, London, on Saturday last, June 25, and continues until Friday next, July 8.

Coventry Gauge and Tool Company Ltd.

The group of " Matrix " grinding machines exhibited by the Coventry Gauge and Tool Company, Ltd., Coventry, includes the largest thread grinder, made by the firm. This machine (Fig. 26) takes work up to 72in long and grinds diameters up to 14½in. It has a traversing wheelhead unit controlled by micro switches operated from stops on a control disc. This disc can be connected to the leadscrew and then rotated one turn for the 6ft traverse of the wheel when used for pass-over grinding; or it can be connected to the workspindle and the stops so disposed that one or more turns of the workspindle are controlled in plunge cut grinding.

The workhead forms an integral part of the base and is driven through gear selectors and pick-off gears by a 1 h.p. motor. The wheelhead carries a 20in wheel and is positioned in relation to the work by an overhead handwheel. Its in-feed mechanism is operated in conjunction with the workhead and traverse cycle through pick-off gears to give various feed rates when plunge grinding.

Fig. 26—Thread grinding machine for 6ft long by 14½in diameter work—Coventry Gauge

This firm's jig grinding machine shown in Fig. 27 has a table with an 18in by 12in working surface and all its controls are power operated for the rapid positioning of the table slides and head. Either of two high-frequency spindles, with infinitely variable speeds from 10,000 to 80,000 r.p.m., can be fitted and the spindle is mounted on a cross slide enabling a radial feed to be imparted during grinding. Hand rotation of the quill can be carried out for segmental grinding through a predetermined arc and a graduated control dial enables this operation to be carried out to a high degree of accuracy. The quill may be inclined in its sleeve up to an angle of 1½ deg. giving accurate control for parallelism and enabling holes to be ground up to 3 deg. included taper. The compound table movements, both longitudinal and transverse, are by hardened and ground leadscrews and a corrector bar system. Each slide movement is separately operated by its own electric motor and final table settings are made by hand with reference to vernier dials reading to 0·0001in.

An internal thread grinding machine recently introduced by the firm is designed, for the production of high precision threads in small diameter bores. Its workhead, which is mounted on a slide, running on roller vee ways, incorporates a hollow spindle and provision is made for coolant to flow, from a built-in system, so that it impinges directly on to the cutting edge of the wheel. Mounted at the rear of the workhead is a multi-ribbed diamond wheel dresser, which has a patented action for correctly shaping the wheel for grinding helical internal threads. When grinding internal threads a parallel sided multi-ribbed wheel will not produce the desired results because when offered to the hole at the necessary helix angle, the first and last ribs alone will be in grinding contact with the work. The dresser overcomes this difficulty by " barrelling " the wheel so that it cuts along its full length with all the ribs contributing equally in the grinding action. The dresser is geared to the workhead and can be set so that the diamond simulates the radius and form of the work to be ground. By passing the diamond across the wheel with the dresser rotated to different positions the barrel shaped wheel is produced.

The wheelhead is controlled by a graduated in-feed handwheel at the front of the machine and this unit can be rapidly retracted clear of the work by an air cylinder to the wheel dressing position. The head carries a high-frequency spindle giving speeds up to 40,000 r.p.m. The complete wheelhead unit has an adjustment to maintain the centre of the grinding wheel on the centre line of the

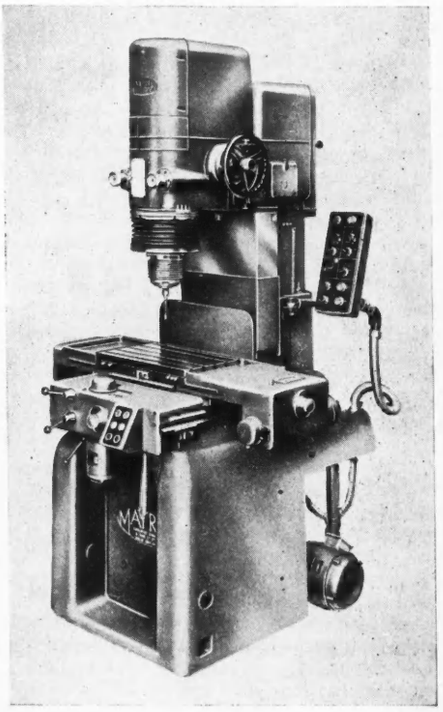


Fig. 27—Jig grinding machine—Coventry Gauge

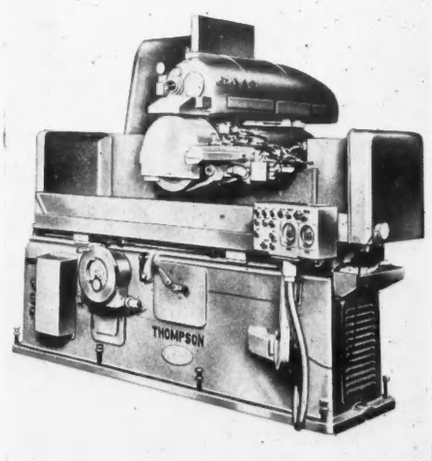


Fig. 28—" Plungematic " surface grinding machine —Coventry Gauge

workpiece and the spindle can be adjusted up to 7 deg. for the required helix angle. The wheel spindle has either a solid mount for plain work or it can be mounted on an eccentric bearing, which, when coupled to the relieving mechanism, gives a relief of 0·001in to 0·003in on the workpiece.

For production work the wheel may be formed by a crushing unit mounted at the rear of the workhead. When the wheelhead has retracted to position the wheel in close proximity with the crushing roller the spindle is automatically connected to an axial drive which rotates the wheel at the lower speed required for dressing. Variation in the effective wheel diameter due to redressing can be compensated for by resetting the infeed handwheel.

The Thompson " Plungematic " grinding machine, now made in this country by the company, is illustrated in Fig. 28. On this fast production surface grinding machine the wheel width covers the area to be ground. Its automatic cycle includes a triple down-feed arrangement with intermediate wheel dressing and compensation, rapid return of the grinding headstock to the start position, and table return to loading position. The triple down-feed arrangement permits the operator to preselect a variable down-feed rate which automatically decreases as the wheel penetrates the work. The automatic wheel dressing and compensation is carried out prior to the last reduction of feed rate. On this machine a 14in by 2in wheel is fitted as standard, but multiple wheels can be mounted on a single arbor for straddle grinding when required.

Alfred Herbert, Ltd.

In addition to a selection of its own machines, those of number of other firms it represents are shown on the stands occupied by Alfred Herbert, Ltd., of Coventry. This firm has long been well known for its capstan and turret lathes and in connection with these machines it has introduced a number of new features to increase productive capacity. One such machine of interest is a " 2 D " capstan lathe, illustrated in Fig. 29, which is fitted with the " Auto-Robot " control system and arranged for fully-automatic repetition bar work up to 1½in diameter. With this control system a punched card is placed over a printed circuit, the holes in the card corresponding to the signalling switch circuits required for a complete work cycle. A scanner device energises the switch circuits which in turn actuate air cylinders connected to machine elements which are normally hand operated. The control system is adaptable to existing machines and is well suited for small repetitive batch work where the use of a multi-spindle automatic is not justified.

Another of the " 2 D " capstan lathes to be exhibited is fitted with a programme system which automatically controls changes of speed and starting, stopping and reversing of the spindle as the turret is indexing.

Basically, the system consists of a punched board panel and limit switches. Plugs inserted in appropriate holes in the panel select the required forward or reverse rotation of the spindle, spindle speed, start and stop and change of spindle rotation. The spindle rotation change is effected at the end of the forward stroke of the capstan slide for withdrawal of a tap or for such operations as parting-off from the rear toolpost. A punched card superimposed over the punched-board panel ensures correct insertion of the plugs for any preselected sequence of operations ; and this card is a permanent record which is easily filed.

The " Autobar " chuck fitted in both of the above machines embodies a mechanism for automatic opening and closing, and used with a weight-operated bar feed ensures automatic feeding to accurate length.

A hydraulic copying attachment is now available with the " 9 C " combination turret lathe which is suitable for chuck work up to 22½in swing and, driven by a 25/17 h.p. motor, can be used with carbide tools. The attachment is for internal, external, longitudinal and transverse profiling, using a master template, and conventional turret tooling for ancillary machining operations. One of the firm's No. 4 " Preoptive " capstan lathes for chuck work up to 15½in swing or 2in bar work is now also available fitted with a hydraulic copying attachment. The copy-turning tools are carried in accurately repositioned toolposts and the change from roughing to finishing tools can be accomplished quickly.

The No. 4 lathe is fitted with a new type of saddle having a single lever for operating both the cross and longitudinal reversible power feeds, which are reversible independently of those to the capstan slide—thereby permitting the cross slide to be fed towards the operator at the same time as the capstan slide is fed towards the headstock. Automatic trip and dead stops, with screw adjustment, for the transverse motion are carried in a hand-indexed four-position stop bar mounted on the right-hand side of the cross slide. Stops for the longitudinal motion are carried by a four-position hand-indexed barrel, close to the bedway on the side of the saddle apron, and are actuated by contact with a five-position rod on the feed box.

The top slide on the saddle, which has been lengthened to ensure protection to the bottom slideways throughout the stroke, can be fitted with a high-speed chasing attachment which is automatically tripped by the longitudinal feed trip stops. A depth-of-cut adjustment device fitted to the cross slide screw avoids over-adjustment and ensures the precise and easy setting of the second and subsequent cuts.

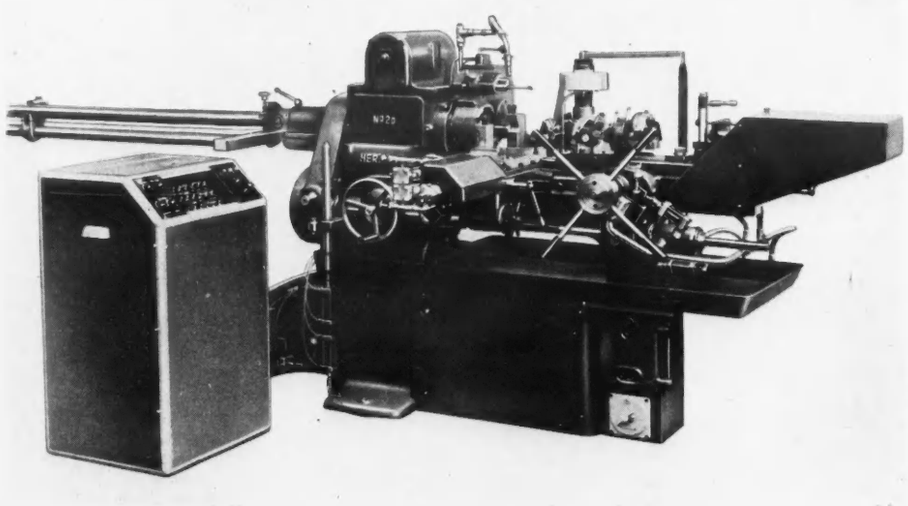


Fig. 29—Capstan lathe equipped with " Auto-Robot " control system—Herbert

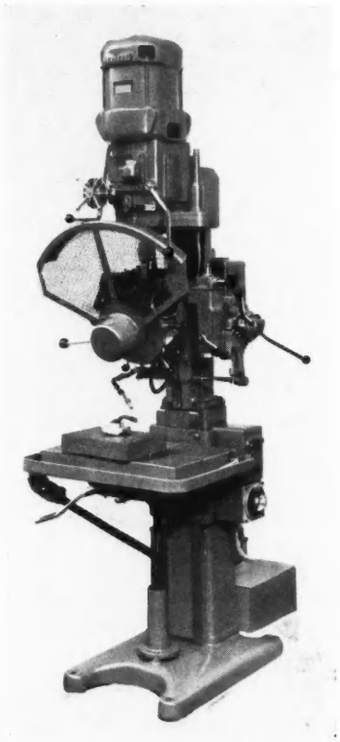


Fig. 30—Turret drilling machine for drills up to ⅞in diameter—Herbert

A turret drilling machine, shown in Fig. 30, drills holes up to ⅞in diameter and can be used for tapping work up to ¾in diameter. Its hand-indexing, six-position, light alloy turret is mounted on a roller bearing and contains six No. 2 Morse spindles running in ball bearings. A single lever unclamps the turret, disengages the drive and indexes the turret ; and the drive cannot be engaged until the turret is correctly located. Depth of hole is automatically controlled for each turret station by adjustable stops. The machine has eight spindle speeds, forward or reverse, between 74 and 2850 r.p.m. and three automatic rates of power down-feed. An automatic reversing attachment for tapping enables right- or left-hand threads to be cut on any one or all the spindles.

A Richards No. 3 horizontal boring and facing machine seen on this stand is representative of a new range of motorised spindle frame machines. It is proposed that in this range there will be three different sizes of spindle frame each of which will be capable of carrying a range of spindle bar sizes. The head can be put on either a standard machine, a floor or a planer design borer. The machine will be equipped with a new automatic positioning system which is operable from

either tape or dials. Infinitely variable feed is applied to all motions of the slides, and power clamping is included for the spindle frame and saddle.

A " Tartar " drill grinding and sharpening machine exhibited can be used with drills from $^{1}/_{64}$in to $^{25}/_{64}$in diameter and is fitted with a projector by which an image of the drill being ground is amplified from ten to sixty times. The drill image is projected on to a screen in front of the operator and crossed wires on this screen are used to check the concentricity in grinding. After each pass across the grinding wheel, the drill is automatically returned to a position in front of the viewing lens for visual checking by the operator who, by rotating the drill in its holder, can check the concentricity.

A " Centri-Matic " internal grinder of Heald's design is arranged for grinding ball tracks in miniature outer races. This class of machine has been supplied for grinding inner races for miniature ball bearings having inside diameters down to 0·040in to within a tolerance of 0·00015in.

A special Lumsden machine for grinding disc brake discs from 9in to 14in diameter is set up for a half-minute floor-to-floor grinding cycle when removing 0·006in of material from each side.

The brake disc is held on a rotating work spindle and the brake faces are ground between two peripheral wheels. Twin work-spindles, housed in a large drum, mounted on a horizontal axis, permit one disc to be ground while another is being loaded. The grinding wheels retract just sufficiently to allow a disc to enter between them. Work size and finish are maintained by hydraulically-operated diamond dressers which automatically traverse the wheel at pre-set intervals. The drum carrying the spindles oscillates slightly around its axis while the disc is being ground to obviate " cording " or truing marks produced by peripheral grinding.

The machine can be supplied with floating work spindles which allow the disc to assume a central position between the wheels before clamping hydraulically. Production is increased in this way by taking advantage of the permissible limit between the flange and the brake faces and removing only the stock necessary to clean up the faces. The in-feed of the grinding heads is variable between 0·002in and 0·030in per minute.

Humphris and Sons, Ltd.

The main display of Humphris and Sons, Ltd., Poole, Dorset, is a combination of equipment for the manipulation, de-coiling, flattening, feeding, cutting and stacking of coils of strip material. This equipment is arranged for fully automatic operation and handles 5-ton coils of 36in wide $\frac{1}{8}$in thick strip. Its general arrangement is shown in Fig. 31 and it includes a power lift, power traverse, coil car ; an automatic motorised centring reel ; and an automatic feeding and levelling machine. A guillotine shear placed in front of the feeding and levelling machine cuts the flattened coil and the cut sheets are deposited on to a hydraulically-operated stacking table.

The coil car has a carrying capacity of 11,000 lb and incorporates a hydraulic power pack providing power for the coil lift. A geared motor traverse unit which moves the car along rails is connected by a cable reel which is laid in a groove as the car traverses. The expanding mandrel of the material centring reel is manually operated in this case, although it can be arranged for hydraulic operation if required. The feeding and levelling machine is designed for feed pitch

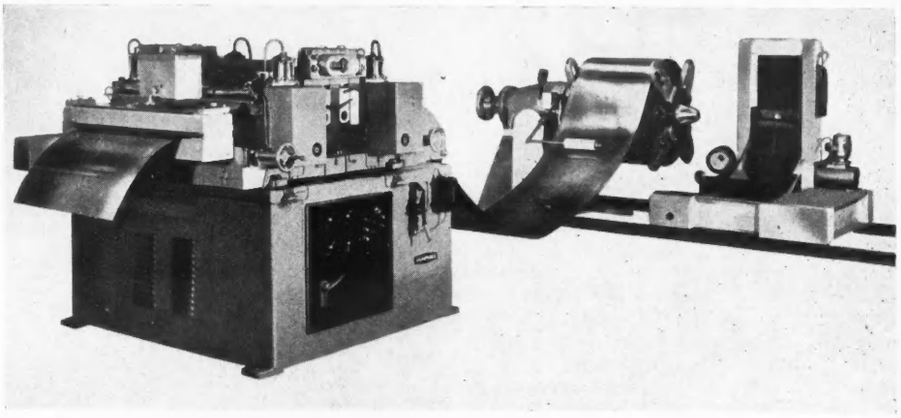


Fig. 31—Combination of machines for manipulating, de-coiling, flattening, feeding and cutting coiled strip material—Humphris

increments up to 36in per press stroke and a double cycling arrangement can be used to feed greater lengths. It incorporates motor-operated screw-down for the levelling rolls and centring lateral stock guides.

A second combined de-coiling and levelling machine being demonstrated is equipped with photo-elastic cell control and is used for feeding material into a 25-ton press fitted with a rack and pinion double roll feed and a crankshaft-driven scrap cutter.

Stuart Davis, Ltd.

Representative of the fine boring machines made by Stuart Davis, Ltd., of Coventry, is the double-ended machine with three heads on each bridge which we show in Fig. 32. The table of this machine has a 26in by 8½in surface pad and over its travel of 15in has a fast feed range from ½in to 60in per minute with rapid approach and return at 23ft per minute. It is electro-hydraulically operated and can be tooled for single-purpose operations with automatic fixtures and multiple tooling or for universal operation. The work fixtures, whether pneumatically or hydraulically-operated from the machine, can be interconnected with the machine cycle. Three individual boring heads can be fitted on each bridge, as illustrated, or a single multi-spindle head can be used for boring a series of holes to precise centre distances. The standard head has spindle speed from 625 to 4000 r.p.m.

The machine is controlled by adjustable cams or dogs fitted to the worktable and actuating plungers in accordance with the required operating cycle. An automatic cycle can be initiated either by movement of a hydraulic control lever, or by push-button, and this lever can be used to slow down or stop the table at any time during the automatic cycle. A spindle is brought rapidly to rest by a brake before table reverse begins and, when boring on the forward stroke only, the table cannot be reversed until the spindle is at rest.

In addition to its fine boring machines this firm is also showing its drill head units incorporating air-hydraulic feed with means of automatic or semi-automatic operation. These heads have a drilling capacity of $\frac{5}{16}$in diameter in steel and a maximum spindle travel of 1¾in. Drives are available to give spindle speeds ranging from 700 to 9000 r.p.m.

The Continental machine tools shown by Stuart Davis, Ltd., include a Chappuis horizontal 2-ton by 20-ton press for the production of small and medium pressings from coiled strip. With its two connecting-rods this machine is of compact design in proportion to its tool area and gives good support for the die blocks. When working simultaneously the two connecting-rods have a combined power of 25 tons to 30 tons and when working independently, 20 ton each. Each rod gives a press stroke of just under 2in and according to the drive selected speeds from 65 to 200 r.p.m. are available. With standard feed rollers strip up to 3·15in wide and 0·118in thick can be handled.

A universal heavy-duty articulated-spindle drilling machine made by Burkhardt and Weber has two groups of fourteen spindles with independent drives. These spindle groups can be used in a number of ways, such

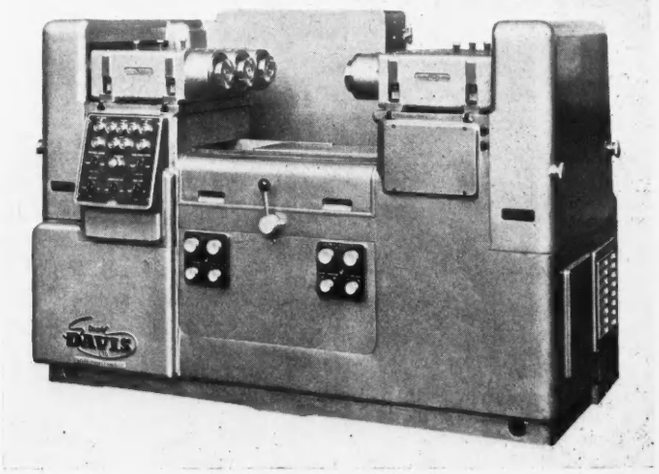


Fig. 32—Double-ended fine boring machine with three heads fitted on each bridge. Work fixtures on the 26in by 8½in table can be interconnected to operate with the machine's automatic cycle—Stuart Davis

as drilling and tapping simultaneously or with each group drilling or tapping, with all twenty-eight spindles, covering a large pattern. Through the spindle gearing a speed range of 68 to 1425 r.p.m. is provided and there is a stepless feed range from 0·393in to 10in per minute through a hydraulic system. The machine can be supplied with articulated spindle carriers covering a drilling surface of 19⅜in by 27½in.

Sykes Machine Tool Company, Ltd.

The equipment manufactured by Gbr. Boehringer Goppingen shown by the Sykes Machine Tool Company, Ltd., Staines, Middlesex, includes the model 44LR lathe illustrated in Fig. 33. This machine, with a swing of 18in and taking 39in between centres, has a Boehringer-Sturm hydraulic drive giving a spindle speed range from 9 to 1800 r.p.m. which is steplessly variable through a single lever control. It is fitted with a hexagon turret and a hydraulic copying attachment, together with a semi-automatic thread cutting unit by which the in-feed and withdrawal of the tool is automatic to pre-set values.

Another Boehringer lathe of interest is a fully automatic "Polycop" machine which is demonstrated turning a motor-car differential housing. It is arranged for longitudinal and transverse internal and external copying with an automatic work sequence through programme control. A transverse copying traverse of 8⅞in used in facing operations covers the full swing capacity of the machine. Tools can be arranged on the long cross slide to follow each other in a follow-on copying method incorporated in the template or trip-controlled work sequence. It is also possible to mount a turret head on the cross slide and this turret operates with three different sets of tools controlled from automatically indexing templates by trip dogs. A turret or boring slide which can be fitted in place of the tailstock can also be incorporated into the automatic work cycle of the machine. On its hydraulically-operated swivel slide, plunge cutting or facing tools can be mounted anywhere along the entire turning length of the machine.

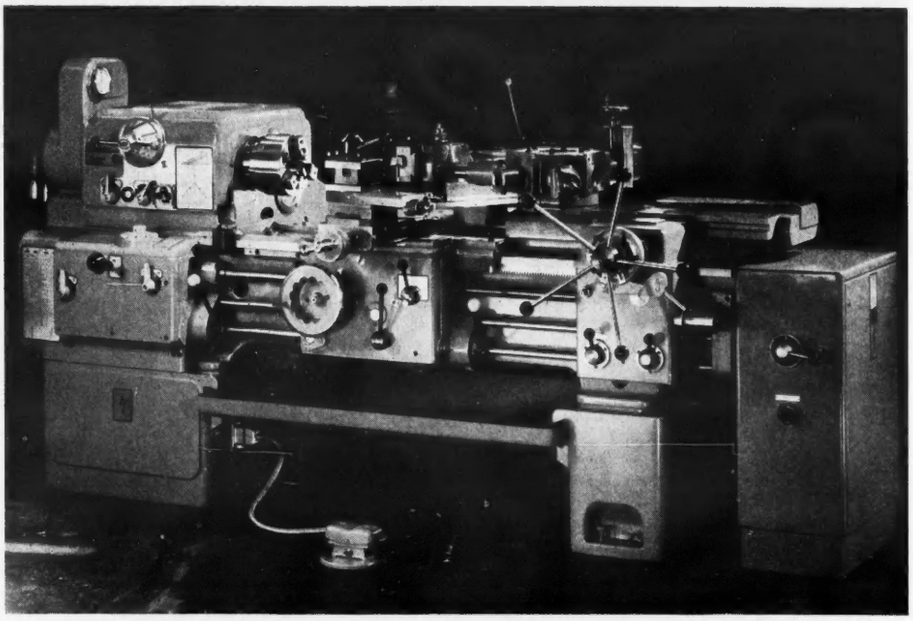
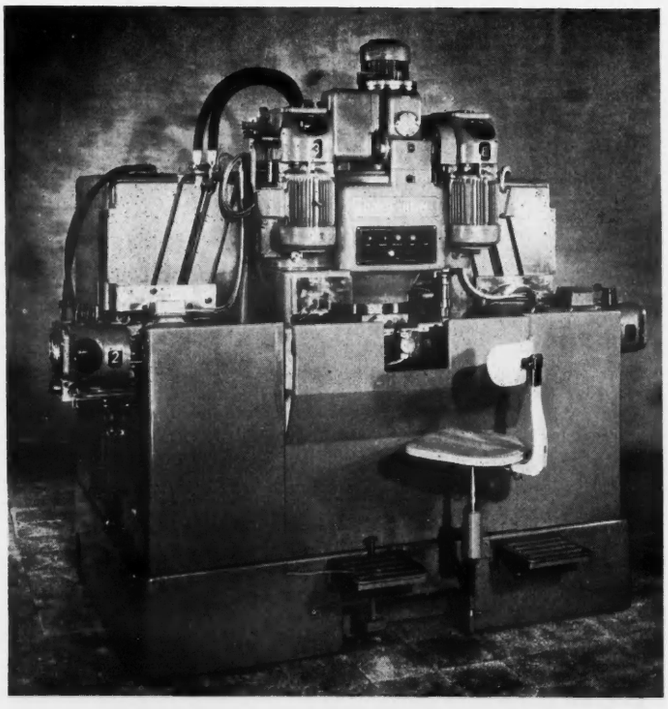


Fig. 33—18in swing lathe with a Boehringer-Sturm drive giving a spindle speed range from 9 to 1800 r.p.m.—Sykes

An eight-step clutch drive fitted in the lathe enables speeds to be changed under load within the work cycle and a steplessly variable drive can be supplied to provide constant cutting speeds. When turret copying, three different programmes with varying cutting speeds can be selected to suit the three turret positions.

The Diedesheim automatic multi-unit machine in Fig. 34 is set up for producing ¾in compression tee fittings from hot brass pressings in a five second cycle. This machine is designed for high-speed production of pipe fittings, valves, &c., from ⅜in to 2in nominal size, and a wide range of spindle speeds provides for different classes of materials. Components are chucked hydraulically in a rotary turret which indexes through three working and one loading stations. Each station contains up to three tools, for operations including drilling, boring, facing and threading. Special attachments can also be used on the machine for sawing, milling, or multi-spindle drilling.

A Ravenburg facing copy lathe with a turning diameter of 43in over the bed is shown with two-dimensional copy turning moulds. It is fitted with the "Unicop" electro-hydraulic two-dimensional system and is particularly designed for machining deep and difficult profiles on such things as dies and tyre moulds which are not suitable for single co-ordinate copying. Normal turning operations can be carried out on the machine without the use of tracer and template and change over from



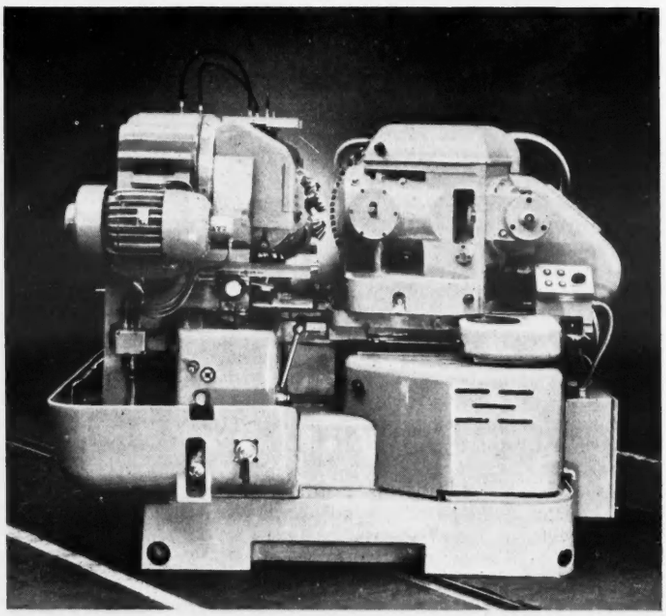


Fig. 34 (Above)—Multi-unit machine with three working and one loading station for the machining of pipe and similar fittings at high production rates—Sykes

Fig. 35 (Left)—Twin-head spheroid bevel gear generator for cutting gears up to 9·4in diameter in pitches from 17 to 2½ D.P.—Sykes

copy to normal turning is effected by the depression of a single button.

The Klingelnberg twin-head, straight tooth, spheroid level gear generator (Fig. 35) employs two large cutter heads, each 23·6in diameter and having thirty-six cutter blades. The blades of the heads intermesh to present the effect of a rack tooth against which the gear to be cut is rolled. The gear rotates simultaneously about its own axis, and with the workpiece indexing head, about the cutter " rack " axis. Two workheads, which are independently adjustable, move alternately into the working position in front of the cutter heads. They may accommodate two identical or two different gears, e.g. a bevel crownwheel and its pinion. As the loading/unloading time on the one workhead coincides with the cutting time of the other, production proceeds uninterupted. The cutter blades, which have effective cutting angles, are of simple form and are readily reground. The spheroid form of the flank is attained by the arrangement of the cutting edges in a straight sided " V."

The high-cutting speeds of this machine (197ft–262ft per minute) and the elimination of feed in a longitudinal direction of the tooth, makes possible short cutting times of from five seconds to forty seconds per tooth, depending on the pitch and the material. Apart from loading and unloading of the work-pieces the operation is automatic, and to a large extent hydraulically operated. Gear blanks up to 9·4in diameter can be accommodated on the machine which is suitable for pitches ranging from 17–2½ D.P. and has a cone angle range from 10 deg. to 80 deg.

Heenan and Froude, Ltd.

To the range of " Multiform " automatic wire and strip forming machines, Heenan and Froude, Ltd., Worcester, has now added the S.3 model for the production of heavier and more complex strip components having a blank length of 12in by 3in wide and up to $\frac{3}{32}$in thick at output speeds from forty to 120 pieces a minute. The die area of this machine (Fig. 36) extends to a maximum length of 31in and facilities are provided for piercing or raising operations from the front or rear of the strip. On this heavy-duty machine, all four camshafts are inter-geared and a flywheel incorporated in the drive system can be manually or automatically engaged so that the considerable inertia built up in the wheel does not have to be dissipated by the rotating parts before the machine can be brought to rest. This feature removes the strains and stresses resulting from sudden stoppages and the controls may be linked electrically to ensure that the machine is automatically brought to rest under conditions such as short feeding, buckling of strip or running out of stock.

To ensure accurate feeding the connecting linkages to the reciprocating feed are arranged in a substantially straight line from the operating crank disc, thus giving a straight pull-through from the crank to the feed. The stock is gripped between a pair of flat dies, one of which is mechanically operated by a cam, and, to ensure that heavy strip is securely held, the grip is positively applied and released by a self-contained locking mechanism which avoids sustained side thrust on the feed slide. The feed slide can be positioned nearer to the ram when using short feeds and thin strip and the provision of a grip throw-out enables the machine to cycle without feeding during tool setting. A separate grip provided to hold the strip firmly on the return stroke of the feed side is operated by two adjustable cams from the front shaft.

Sufficient room has been provided on the bed-plate for two 30-ton press units as well as the standard front cut-off. A horizontal press unit has a standard die space of 10in and the entire assembly can be adjusted along the bed-plate to obtain the best working position. The machine can be supplied with either one or two rams and when the standard cut-off is not required a third ram may be incorporated. In each case, the rams may be operated from the front or rear of the machine, thus permitting the burr on a component to be placed either externally or internally, as required, or to allow for bending or raising from front or rear.

Each of the four slides is operated by a separate hardened and ground steel cam capable of exerting a working force of 6 tons.

R. S. Brookman, Ltd.

A number of special purpose drilling set-ups have been arranged by R. S. Brookman, Ltd., Parkside Works, Rothley, Leicester, to demonstrate the uses of the " Selfeedril " system. The " Selfeedril ' is a pneumatically-operated unit drilling head of small cross section in which the spindle is driven by an air motor and it incorporates an air pressure forward feed controlled by a simple on/off valve. Once the air supply has been initiated the drilling and withdrawal cycle is fully automatic and an oil dashpot with a two-stage control fitted gives rapid approach characteristics.

Available with these drills there is a selection of clips, columns and bars from which a drilling structure can quickly and simply be constructed to support the units in the required working positions. A single air hose connection only is required to the drills and a series of components is available to build up the air distribution manifold of a set-up. The drill units are made in a number of forms to suit different applications and drill speeds and tapping heads, also available, are designed to work automatically in conjunction with the drills in a fixture without need for auxiliary control means.

George Cohen Sons and Co., Ltd.

Together with a number of Raskin power presses George Cohen, Sons and Co., Ltd., 23–25, Sunbeam Road, London, N.W.10, is showing a downstroking hydraulic Barnes press with a rated capacity of 100 tons at the maximum operating pressure of 3000 lb per square inch. It has a built-in hydraulic system supplied by mono-radial Fraser pump driven by a 7½ h.p. motor and running at 960 r.p.m. The bed area is 54in by 26in and the general construction of the machine can be seen in Fig. 37.

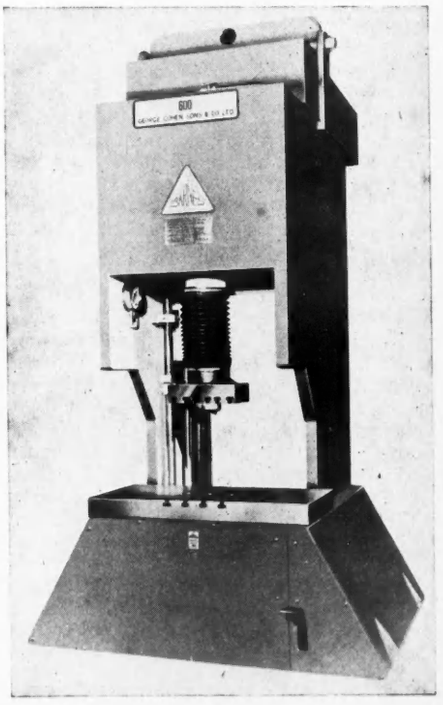


Fig. 37—100-ton downstroking hydraulic press—Cohen

With a down ram speed of 35in per minute and ram return speed of 50in per minute, the independent pressure control valves that are used on the approach and return strokes enable a predetermined stripping pressure to be used if so desired. An automatic stroking device enables single or repeat stroking to be selected at will, the stroke being variable from a minimum of 1½in to a maximum of 12in. Short strokes can be selected to operate at any given point between the maximum and minimum.

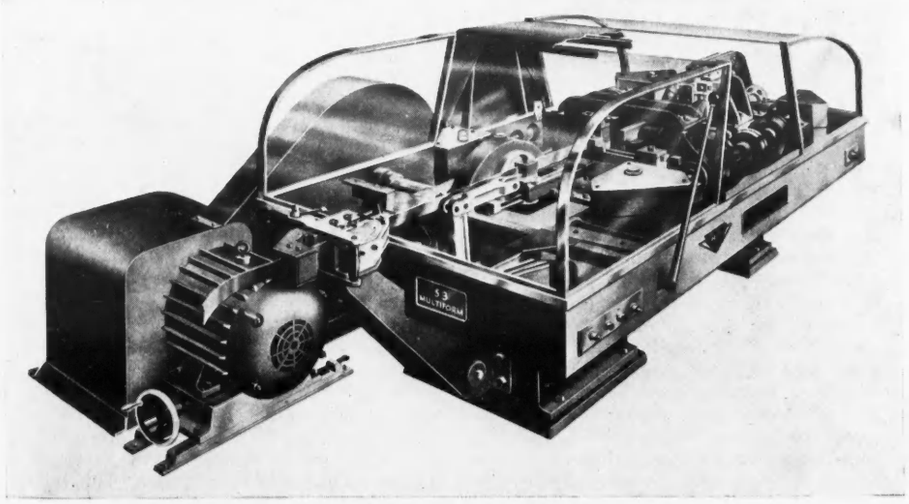


Fig. 36—" Multiform " wire and strip forming machine for strip up to 12in long by 3in wide and 3/32in thick—Heenan and Froude

Amongst the Continental machine tools on this stand is one of the centre lathes built by Ateliers Demoot for screwing drilling rods and pipes used in the oil industry. The machine incorporates automatic cycle screwing equipment and can be fitted with a hydraulic copying unit in place of the conventional cross slide for preturning or boring duties. Its headstock spindle admits work up to 12½in diameter and can be fitted with air-operated chucks.

When screw cutting, following copy turning or boring, is to be carried out on the machine the copying slide is advanced to bring the tool into engagement with the work, and movement of the cross slide is then controlled by a rear-mounted slide which can be set to suit the taper angle of the threads. Screw threads can be cut for a maximum depth of 0·250in, and at the end of each pass of the saddle the cross slide is automatically moved for a maximum distance of 0·260in to bring the cutting tool clear of the work during one revolution of the headstock spindle. The saddle is then traversed towards the tailstock end of the bed and the cross slide advanced in readiness for taking the next pass, which is started automatically. Because the tool is rapidly brought clear at the end of the cutting stroke, any spindle speed, up to a maximum depending upon the diameter of the work and the pitch of the threads, can be employed for cutting threads which may extend close up to a shoulder.

The movement of the saddle on the bedways is controlled by a fine pitch leadscrew enabling taper pipe threads to be cut to A.P.I. tolerances. The depth of cut to be taken on the work at each pass of the saddle can be reset by lever and provision is made for the in-feed movement to be automatically reduced in the ratio of 2 to 1 for the last two cuts, to give a good finish on the threads. Adjustable stops enable the movement of the cross slide away from the work to be restricted to a minimum when internal threads are being cut thus enabling a toolholder bar of maximum diameter to be employed.

When the copying unit is mounted on the cross slide in place of the top slide it is used with a template carrier which can be adjusted longitudinally and transversely and clamped to the bedways. The copying slide is set at an angle of 30 deg. to the work axis, and carries a top slide with a four-way toolpost. This unit enables the end face, taper portion, flanges, undercuts, and chamfers on the work to be copy turned at a single setting. The depths of cut when a number of passes is to be taken on the work during the copying cycle can be preset by stops mounted on an indexing holder.

The toolpost is fitted with separate single-point tools for copy turning, and for taking rough and finishing cuts on screw threads. These tools are accurately pre-set in relation to each other with the aid of multiple dial indicators.

Selson Machine Tool Company, Ltd.

The Continental machine tools on the stand of the Selson Machine Tool Company, Ltd., Sunbeam Road, London, N.W.10, include an unusual design of two-spindle horizontal and vertical milling machine of Ateliers Georges Vernier. This machine has twin columns secured to the bed and braced together at their upper ends, their inner surfaces forming guideways for a counterbalanced carriage. The carriage has a vertical traverse of just over 35in and it houses a horizontal spindle, whilst a universal spindle is supported on a ram slide on its upper surface.

By adjustment of the carriage in the columns the horizontal spindle can be set to a maximum distance of 37½in above the table surface. This spindle is driven by its own motor of 15 h.p. or 20 h.p. and has sixteen speeds from 12 to 1000 r.p.m. The ram slide has a lateral travel of 39in and its spindle is mounted in a swivelling head. This spindle, driven by a 12 h.p. motor, has sixteen speeds from 25 to 2000 r.p.m., and when the head is in a vertical position its nose is 40in above the table. The maximum distance between the spindle axis and the carriage is 44in when the ram is fully extended.

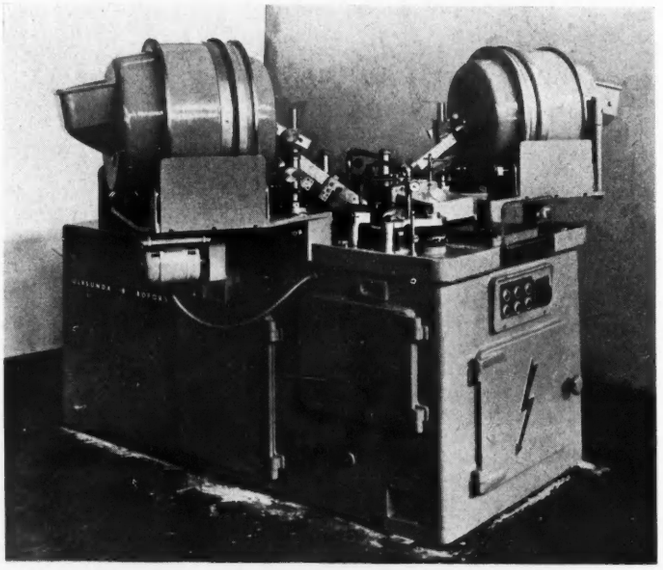


Fig. 38—Thread rolling machine operating on both the forward and return passes, using a pair of flat dies on each side of the main slide—Selson

The machine has a 79in by 25in table which can be swung through 40 deg. on either side of the central position and is mounted on an intermediate table with a longitudinal traverse of 59in. The main table saddle has a cross traverse of 24in along the bedways at right angles to the columns. A Ward-Leonard drive gives steplessly variable feeds to the four slides and a separate rapid traverse drive is fitted.

A 2½in spindle Pluart horizontal boring machine on this stand has an optical measuring system stated to give readings accurate to within 0·0004in. On this machine particular attention has been given to simplifying the controls. For example, a single lever controls automatic feeds to both spindle head and table slides and, by allowing their simultaneous use, permits oblique surfaces up to 45 deg. to be milled. Mounted in this same lever is a push button controlling the rapid traverse, rapid movement continuing for as long as the button is pressed and reverting to the selected feed on release. Spindle speed and feed rates can be preselected on dials and engaged as required whilst the machine is running.

A Bofors thread rolling machine shown in Fig. 38 has capacity for rolling threads up to $\frac{3}{16}$in U.N.C. by 1in long in blanks of up to 120 Brinell and up to $\frac{1}{4}$ U.N.C. by 1½in long in blanks of 270 Brinell hardness. This machine has a pair of flat dies mounted on each side of the main slide, and workpiece blanks are fed to each dieset alternately at the ends of the working stroke. With this arrangement, thread rolling is thus carried out during both directions of slide travel. The slide is mounted on preloaded ball bearing guideways, in order to ensure the required accuracy and to reduce maintenance. Either of the two rotary-drum hopper feed units may be operated independently of the other, so that only one set of dies may be employed, or two different parts may be produced simultaneously. Blanks are delivered to the dies by way of inclined chutes which are vibrated electro-magnetically, thence by positive feeders.

A Praehoma rotary table surface grinder has two 24in diameter worktables mounted on a carriage which is traversed to bring the tables alternately into the working position. This arrangement enables one table to be loaded whilst the parts on the other table are being ground under the vertical spindle wheelhead. Steplessly-variable table speeds from 15 to 100 r.p.m. are provided and down-feed is applied to the wheelhead at rates from 0·005in to 0·2in per minute. A " Finisolo " control system used causes the down-feed to be automatically stopped when a pre-set amount of metal, up to a maximum of 0·2in, has been removed from the work. The wheelhead is then caused to dwell for a variable period from six seconds to 120 seconds, for sparking out before it is raised clear of the work.

Midgley and Sutcliffe, Ltd.

The radial drilling machines and milling machines demonstrated by Midgley and Sutcliffe, Ltd., Hunslet, Leeds, are of conventional modern design and include the recently introduced heavy-duty vertical-production milling machine we illustrate in Fig. 39. This machine is intended for a high rate of metal removal and its range of feeds and speeds allow full advantage to be taken of tungsten carbide tools using positive or negative rake.

The Nitralloy steel spindle has a No. 50 B.S.S. taper and runs in selected roller-bearings, the thrust being taken by a pair of angular contact ball-bearings mounted in an adjustable quill, with a pair of ball-bearings in the upper housing. This spindle has a vertical movement of 4in controlled by a handwheel fitted with micrometer dial.

The knee bracket is of reinforced construction with a wide top bearing surface to give maximum steadiness under heavy cutting loads. The well-supported saddle provides a long bearing surface for the table, which has a 33in longitudinal feed provided by a hydraulic system contained in the knee

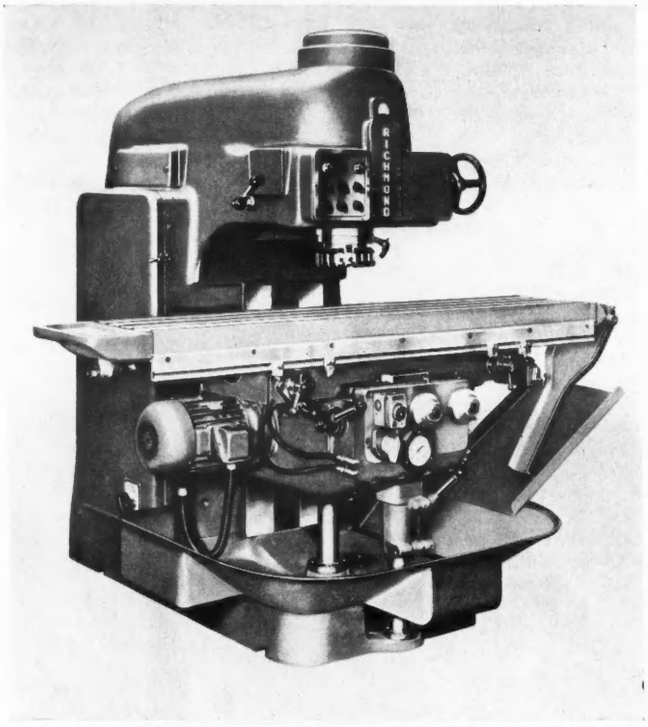


Fig. 39—Heavy-duty vertical production milling machine with twelve spindle speeds from 200 to 2500 r.p.m.—Midgley and Sutcliffe

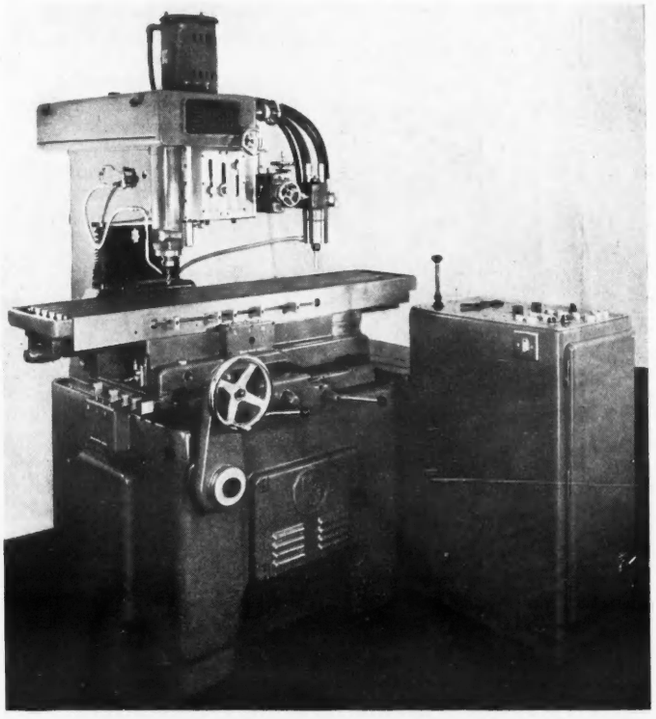


Fig. 40—Three-dimensional, hydraulically-operated diesinking machine with means of hand, semi- and fully-automatic control—Geo. H. Alexander

and slide structure. This system gives variable feed rates from 1in to 200in per minute, and a quick traverse rate of 250in per minute.

The 20 h.p., two-speed main power unit is built into the column which also accommodates the main drive gearbox. This gearbox is a self-contained unit, mounted co-axially with the spindle and it has only two lines of ball and roller bearing mounted shafting. Five magnetic clutches and ten gears, in conjunction with the two-speed of the driving motor, provide a total of twelve spindle speeds (200–2500 r.p.m.) controlled by an independent selector switch.

George H. Alexander Machinery, Ltd.

A three-dimensional automatic diesinking machine just developed by George H. Alexander Machinery, Ltd., 82-84, Coleshill Street, Birmingham, is shown in Fig. 40. This machine is hydraulically operated in all three directions at a 1 to 1 ratio and can be controlled by hand, semi- or fully automatically. Its 12in by 51in table has a longitudinal traverse of 18in and a cross traverse of 10in at steplessly variable speeds up to 20in per minute. Under hydraulic and automatic control the spindle and stylus have a vertical movement of 3in and the column carrying the heads has a vertical adjustment of 12in by hand, giving a maximum setting distance of 16½in between the spindle nose and worktable.

The main hydraulic control valve of the machine is carried on three slides to give it a three dimensional adjustment relative to the spindle head and all the slides are equipped with zero setting micrometer dials and locking handles. This adjustable valve head is attached to a vertical slide which carries the spindle head on its opposite end. Thus both the spindle head and the control valve are rigidly supported by their own slides, which are joined by a strong casting which accommodates the elevating cylinder and piston. The rise and fall is effected by a piston control valve which operates when the stylus is deflected either vertically or sideways.

A plate valve inside the main hydraulic control valve operates a hydraulic brake when the stylus is deflected sideways by contacting a vertical wall. Movements of the stylus on being deflected by 0·008in opens a valve port which, in turn, stops the table traverse in the appropriate direction. The valve head and spindle then rise simultaneously until the stylus automatically centralises at the end of its vertical travel allowing the table movement to continue. When climbing angular slopes, the machine table slows down so that under all circumstances, optimum cutting conditions are obtained automatically. A graduated dial in front of the main copying valve provides means of variation in the rate of climb and for locking the rise and fall. Vertical movement is arrested by a full turn of the dial.

The worktable can traverse and pick feed automatically in four directions—movement of the table rams being checked by the main hydraulic copy valve as explained above. The feed range of traversing and pick feeding varies from 0in–20in per minute for the traversing and from 0·002in–0·25in for pick feeding. Table movements are pre-set for length of travel by adjustable trips operating electro-hydraulic servo valves which effect the reversing action.

By the use of an intermittent feed switch between the table reversing switches it is possible to slow down the table movement any desired number of times by pre-setting a number of intermittent feed dogs. Feed slow-down when approaching rapid profile changes allows fast cutting speeds over the plainer parts of a contour.

When producing cavities of irregular aperture, it is possible to set height limiting controls, which are arranged between the main valve and the workhead, for automatic table reversal when the cutter has reached a required height or depth. This arrangement restricts the cutting action to the cavity part of a mould, avoiding idle movements, and also enables the setter to restrict the cutting action to a particular part of a mould contour.

Interchangeable roughing and finishing spindles are provided to obtain optimum results from the machine. The roughing spindle has an infinitely variable speed range of 75–1250 r.p.m. and the finishing spindle a speed range of 400–10,000 r.p.m. Both spindles have a collet capacity ¼in–⅝in diameter for parallel screwed-shank cutters.

Startrite Machine Tool Company, Ltd.

Machines of interest in the sawing equipment on the stand of the Startrite Machine Tool Company, Ltd., Star Mill Lane, Chatham, Kent, include the "Wespa" sliding table bandsawing, filing, polishing and friction cutting machine. This machine is available with up to 36in by 25in throat capacities and that we illustrate in Fig. 41 has a 24in throat and takes 14½in under the guides. A sliding table fitted on this machine runs on steel balls and is operated either by handwheel or a hydraulic cylinder, giving an adjustable feed rate up to 10ft per minute, at pressures adjustable up to 215 lb per square inch according to the size and machinability of the work. Contour sawing is easily carried out to lines with the workpiece being advanced by hydraulic table feed and achieving directional control by a handwheel which actuates the workholder through a guide chassis.

The band wheels are driven through a two-speed gearbox and a 10 to 1 variable speed pulley unit, there being two stepless speed ranges from 50ft to 5000ft per minute and 40ft to 10,000ft per minute. The upper wheel is slide mounted with compensator spring blade tensioning and blade tracking is effected by a handwheel. Standard guides take blades ⅛in to ½in wide and special guide pieces are available to accommodate blades up to 1in wide. Mounted in precision ground slide blocks the toolposts are adjusted by handwheel and screw, the upper toolpost being hydraulically moved and locked on models fitted with hydraulic feed tables.

Flash welding units built into this machine

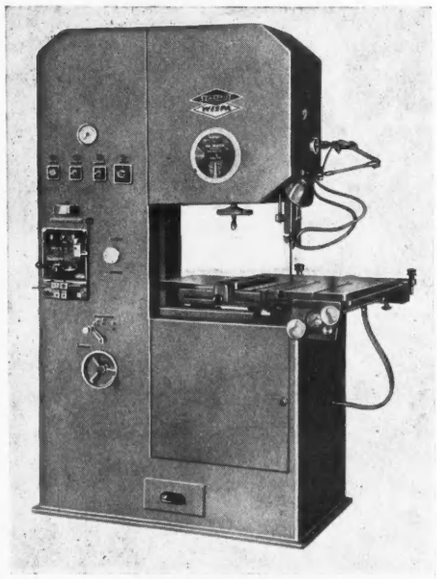


Fig. 41—Bandsawing machine fitted with a hydraulic feed table—Startrite

have annealing controls, a band thickness gauge and motorised grinder. An air applicator, mounted on the upper tool guide, can also be utilised for coolant application. A job selector indicates correct tool feed and speed for sawing, filing and polishing forty eight different industrial materials.

The " Metalin " automatic bandsaw shown on this stand is made under licence by the company and is designed to cut up to 12in diameter bar or 11in by 14in rectangular material. It is fully automatic in operation and is stated to cut lengths up to 20in to an accuracy of 0·010in. A band 1in wide by 143in long by 0·35in thick is used and seven operating speeds from 65ft to 410ft per minute are available.

George Richards, Ltd.

The range of horizontal and vertical boring machines made by George Richards, Ltd., Broadheath, Altrincham, Ches., has been completely redesigned and our illustration shows a 3½in diameter traversing spindle, horizontal boring, facing, milling, drilling, and tapping machine representative of the new form of construction adopted. This machine has a 42in diameter facing capacity, its facing head speeds varying from 7 to 210 r.p.m. and its spindle speeds from 7 to 1250 r.p.m. Its motorised spindle frame incorporates electro-magnetic clutches, automatic prestart lubrication, preselection of speeds to the facing head and traversing spindle and there is a steplessly variable feed range to all motions of the slides. Three basic sizes of spindle frames are made, each designed to carry alternate diameters of traversing spindles to cover a range of machines with spindles from 2½in to 7in diameter, and having facing heads to machine face and edge up to 60in in diameter. These spindle frame units can be mounted on horizontal, floor or planer type boring machines. The machine exhibited is fitted with the maker's automatic co-ordinate positioning system with either tape or dial control. In this equipment the actual position from a pre-set datum is displayed on numbered tubes to show the actual dimension in decimal form.

Pearson Panke, Ltd.

A transfer press of 160 tons capacity and having eleven tool stations shown upon the stand of Pearson Panke, Ltd., 1–3, Hale Grove Gardens, London, N.W.7, is typical of this range of machines of Schuler design. It has a tool pitch of 360mm, a stroke of 380mm and is designed for making from twelve to thirty-six strokes a minute. In these machines the pitmans are housed in the uprights so that the pressures from the ram are transmitted directly to the anchor columns. If required a pressure stage can be provided immediately underneath the pitman in the right-hand upright to make possible embossing or sizing work without affecting the remaining tool stations. The machine and tooling are safeguarded against damage by a series of safety devices which switch the power off immediately in the event of a component not being ejected in any tool station or the development of faults in the feed, pressure overloads, or failure in the air supply or the lubrication system. These devices operate in conjunction with the single-plate clutch and brake.

An example of the new Schuler double- and treble-acting hydraulic drawing presses is shown in Fig. 43. In the operation of this machine the upper sheet-holding ram moves below the main ram so that any tilt in the sheet holder, due to variations in the flow of the material during drawing or variations in the sheet thickness, is not transmitted to the drawing ram.

On the standard machine, the sheet-holder pressure is generated by four differential pistons in such a way that only 20 per cent of the sheet-holding pressure has to be taken from the main ram pressure. This arrangement eliminates the need for a

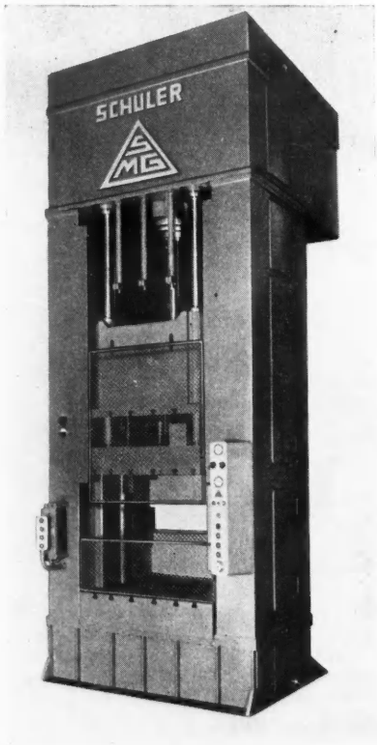


Fig. 43—Double and treble-acting press—Pearson Panke

separate pump for the sheet holder. The pressure in each of the four cylinders is controlled independently, which is useful when drawing irregularly shaped components.

By operating changeover valves, the sheet-holder cylinders can be connected to the main pressure circuit to operate the machine as a single-acting, a double-acting or a treble-acting press.

For working as a single-acting press, the drawing ram and sheet holder are coupled together and double action may be obtained by using a hydraulic drawing cushion in the table. For operation as a double-acting press the drawing ram and sheet-holding ram operate at their respective maximum pressures. A hydraulic drawing cushion is fitted into the table of the press for treble acting and this cushion also serves as an ejector to remove work from the die. The cushion is fitted with control means by which its pressure can be varied during the press stroke to obtain a constant specific pressure, as the area of sheet holding decreases when material is drawn into the die.

Rockwell Machine Tool Company, Ltd.

The selection of Continental machine tools upon the stand of the Rockwell Machine Tool Company, Ltd., Welsh Harp, Edgware Road, London, N.W.2, includes the Bemag production boring machine which is arranged

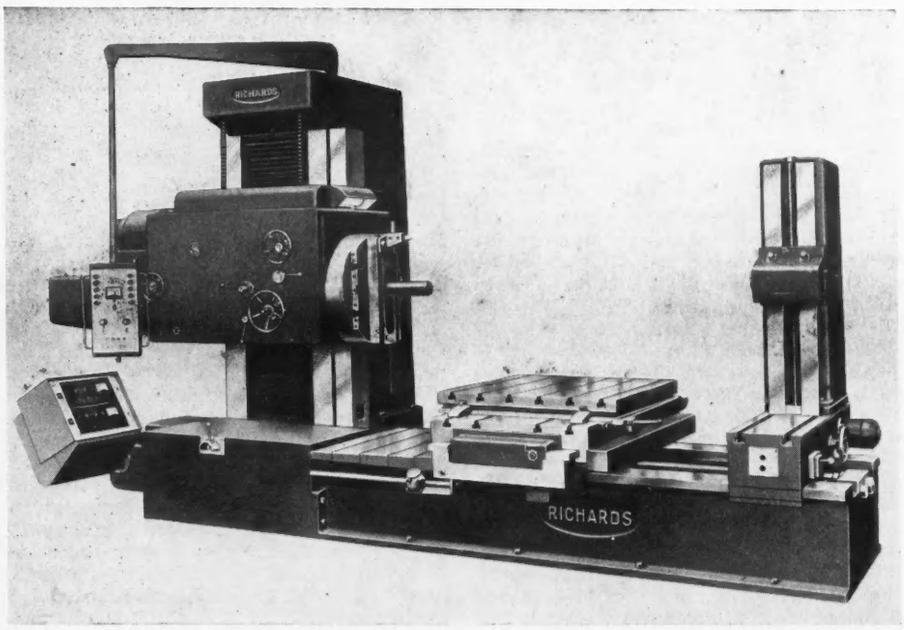


Fig. 42—Universal horizontal boring, facing and milling machine with automatic co-ordinate positioning equipment—Richards

for the preselection of co-ordinate settings, spindle speeds and feeds. This machine (Fig. 45) has a bridge design column carrying a longitudinal slide on which there is a cross slide. Each of these hydraulically operated slides is a self-contained unit and incorporates precision end-measuring rods which are held in a magazine and electrically selected as required for setting purposes. The machine

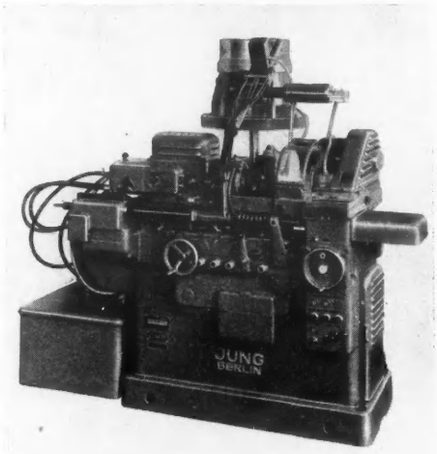


Fig. 44—Automatic internal grinding machine suitable for small batch production grinding bores up to 1⅝in diameter by 3¼in long—Rockwell

has a 63in by 38in table, its longitudinal spindle traverse being 50in and cross spindle traverse 30in, whilst the maximum distance available between the spindle and table is 30in. Four screws, fitted with backlash eliminators, are used for vertical table adjustment purposes and are driven through planetary gearing. When the height has been set the table is automatically clamped upon release of the control push button. The longitudinal and cross slides are also equipped for automatic hydraulic clamping.

The machine is designed to carry out drilling, milling and boring operations under programme control without need for marking out or jigs. Co-ordinate settings are made by a simple punched-card programming system or by moving two groups of counter wheels fitted to the front of the machine next to the spindlehead. Each group of counter wheels contains six figures, the last one reading 0·0001in, going up in steps of two, all other digits advancing in steps of one. Thus the machine can be set, for instance, to 29·4624 or 29·4626. Preselection of the co-ordinates for the next hole to be drilled or bored can be made whilst the machine is still working on the first hole. As soon as the spindle has been retracted from the first hole, it only remains for two buttons to be pushed and the machine will automatically re-arrange itself to the previously selected co-ordinates. The machine has eighteen spindle speeds from 35 to 1800 r.p.m. and nine boring feeds, in addition to infinitely variable milling feeds, the spindle being driven by a 5½ h.p. motor.

A group of Werner milling machines includes various sizes of that maker's standard electrically-controlled horizontal, vertical and universal models and a heavy-duty vertical design with programme-controlled three-dimensional automatic equipment. This last machine with a 43in by 12in table has push-button preselection of table and knee movements and for programme control purposes is equipped with forty push-button stations.

Amongst a number of Jung grinding machines there is the automatic internal grinder shown in Fig. 44, on which, it is stated, a change-over time of thirty minutes is all that is needed when working on small batches. It can be arranged to grind to size either by the setting of the dressing diamond or by plug gauging. When using the diamond-setting method the diamond is automatically raised, dressing of the wheel being carried out between the roughing and finishing operations. When the plug-gauge method is employed, the wheel is dressed when the first section of the gauge enters the work, the finished size being determined by the entry of the second section. The machine will grind bores up to 1⅝in diameter by 3¼in long. Its headstock spindle, has two speeds, 640 and 1000 r.p.m., and after completion of the grinding cycle is automatically braked. The headstock swivels up to 30 deg. but for automatic grinding it can only be turned through up to 10 deg. Variable-pressure hydraulic chucking is push-button controlled and a hydraulic table drive gives infinitely variable speeds up to 36ft per minute. Two cross slide feed systems are used, one mechanical and one hydraulic. Wheel dressing compensation is achieved mechanically without altering the hydraulic setting and the wheel position relative to the bore of the work remains constant. The machine exhibited is equipped with magazine loading and is set up for grinding bores of bevel gears which are tipped into a vibrating hopper where they are automatically sorted and fed to the magazine. Chucking, centring and ejection of the work-pieces are automatic, finished parts leaving the machine via a chute.

A two-part single action British Clearing press (Fig. 46) exhibited has an 84in by 60in bed and a capacity of 300 tons.

It operates at sixteen strokes a minute and and with a stroke of 20in has a 12in slide adjustment. A 40 h.p. motor drives the press through a " Tornadyne " clutch and brake

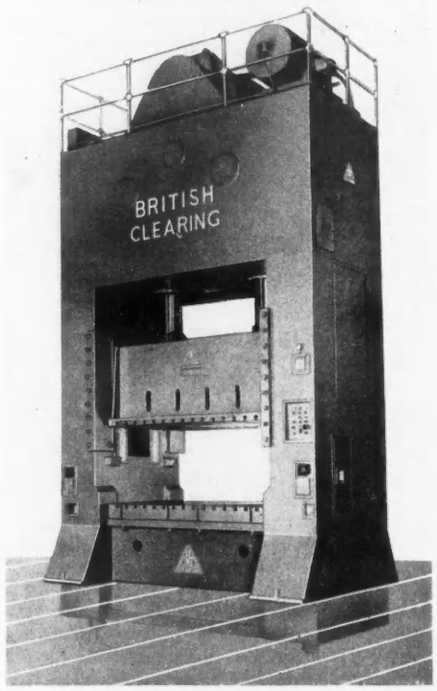


Fig. 46—300-ton British Clearing press with an 84in by 60in bed—Rockwell

unit and all wiring, air and lubricating lines are contained within the housings. The controls mounted on the uprights and an automatic-operation nine-station switch is used for controlling and timing the working sequence. A pneumatic die cushion with a capacity of 25 tons at an air pressure of 100 lb per square inch and having a stroke of 6in can be built into the press if required.

A Thiel tool room duplex milling machine shown has power feed and rapid traverse to the longitudinal and vertical motions of the table and to the cross motion of the horizontal milling spindle headstock. All three movements have dials graduated in 0·001in, vernier scales being fitted and provision made for using slip gauges and dial indicators on all movements. The 32in by 11in worktable, which can be swivelled and tilted in all directions, has a hand cross movement of 5in. Twelve speeds, 60-1200 r.p.m., are provided for the horizontal spindle with eight feed rates from ⅜in to 6¼in per minute for both spindle headstock and table. The spindle is driven by a 2·2 h.p. motor, a separate motor providing the feed and rapid traverse drives. Various attachments which can be mounted on the overarm situated over the horizontal spindle headstock, include a jig boring head with three power feeds, a vertical milling and drilling head with twelve spindle speeds and a slotting attachment. Horizontal adjustment of this overarm provides a deep throat for machining large or awkward work and an attachment mounted on it can be swivelled clear of the horizontal spindle.

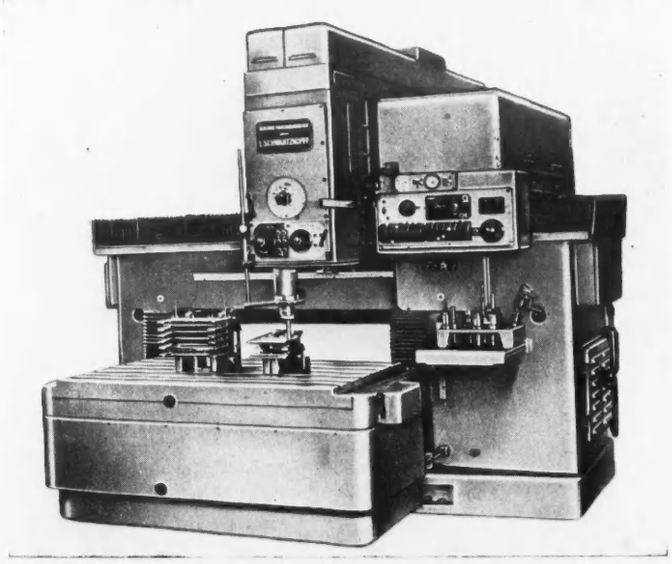


Fig. 45—Production boring machine incorporating equipment for the preselection of co-ordinate settings, spindle speeds and feeds. With this equipment, drilling, milling and boring operations can be carried out under programme control—Rockwell

Keelavite Hydraulics, Ltd.

An electro-hydraulic servo valve introduced by Keelavite Hydraulics, Ltd., Allesley, Warwick, enables hydraulic systems to be accurately controlled by electronic equipment. It is made in two sizes, one model giving a 25 to 30 gallons per minute flow for a pressure drop of 1000 lb per square inch and the other 100 gallons per minute for an equivalent drop. This design of valve (Fig. 47) consists of a rotary torque motor driving a pilot valve, which provides one stage of hydraulic amplification, to

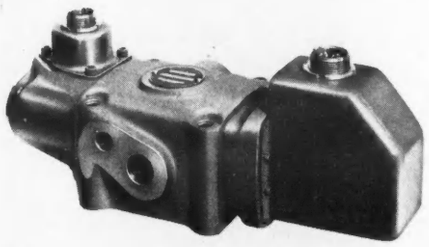


Fig. 47—Electro-hydraulic servo valve to enable hydraulic systems to be electronically controlled—Keelavite Hydraulics

control the position of the second stage piston. The first stage consists of a nominally zero, lapped, three-way valve which is driven against springs by a rotary torque motor fitted with balanced windings of either low or high impedance. An inductive rotary pick-up, also driven by the motor, is used to close a feed-back loop around the pilot valve. The second stage of the assembly consists of a conventional piston valve which may be fitted with either a four- or five-way piston.

The servo control unit consists of a torque motor amplifier, two error amplifiers, two phase-sensitive rectifiers, and a.c. and d.c. power supplies. Carrier frequencies in the range of 400 c/s to kc/s may be used to energise the pick-offs. In operation the centre (jack) port of the pilot valve is connected to one end of the second-stage piston, which full servo pressure is applied to the other end, which is half the area of the first end. Full servo pressure is applied across the pilot valve. Consequently, if the pilot valve is centred, balanced forces are applied to the ends of the second-stage piston, since under these conditions the pressure at the jack port is half servo pressure, and the second-stage piston will remain stationary.

A small deflection of the pilot valve disturbs the force balance, and the velocity of the second-stage piston becomes proportional to the deflection of the pilot-stage piston, and to the electrical input signal to the torque motor. In order to make the position of the second-stage piston proportional to the input signal, a feed-back loop is closed around the second stage, and for this purpose there is an inductive pick-off of the rotary type which is driven by a crank actuated by one end of the second-stage piston.

Fig. 49—Electronically-controlled Sperry/Orcutt dividing equipment—Gear Grinding

Gear Grinding Company, Ltd.

The gear inspection equipment of new design to be seen upon the stand of the Gear Grinding Company, Ltd., Shirley, Solihull, Warwickshire, includes the " Orcutt " Mark VI individual base circle involute measuring machine. This machine (Fig. 48) has been developed specifically to accommodate traction gears such as slab gears up to 48in diameter and stem pinions up to 30in outside diameter and 36in long.

The machine has a telescopic centre support column to provide long guides and give a maximum distance between centres of 36in and this distance may be increased up to 60in in some cases where the diameter of the pinion shaft is below 5in. Slab gears up to 48in outside diameter are accommodated by swinging the upper centre through 180 deg. and retracting the centre support column into the base. Swinging of the upper centre is effected by a hydraulic cylinder supplied by a small hand-operated pump.

The lower centre is located in a ball cage mounting which allows easy withdrawal and replacement of centres or arbors whilst maintaining concentricity. Pressure indicating devices are built into the compound slide and upper centre so that successive gears may be checked under the same conditions of pressure between base circle and straight-edge and between centres.

In view of the accuracy required of the recording equipment, it was decided to adopt the " Talymin " gauge, amplifier and rectilinear recorder manufactured by Taylor, Taylor and Hobson, Ltd., and this equipment has been modified to suit the special requirements and built into the machine. The side acting gauge head, with a measuring pressure of $^1/_5$oz, has gauging tip comprising a stylus mounted on the end of a close-coiled spring which yields when loads are applied greater than those required for operation. This tip is removable so that different forms of stylus can be inserted. The amplifier, incorporating the power pack, is mounted in the base of the machine and six magnifications, normal to the surface, of $\times 100$, to $\times 5000$, can be selected by operating a rotary switch.

The recorder provides a graph having rectilinear co-ordinates and it uses electrical marking of " Teledotus " paper. The paper drive in the recorder is direct from the straight-edge of the machine, enabling errors to be identified with their position along the path of contact. A gearbox, built into the recorder, provides for magnifications of $\times 1$, $\times 2$, $\times 4$, along the line of contact.

In conjunction with the Sperry Gyroscope Company, Ltd., the Gear Grinding Company, Ltd., has developed the electronically-controlled dividing equipment illustrated in Fig. 48, the platen of which, it is stated, can be positioned to an accuracy of ± 2 seconds

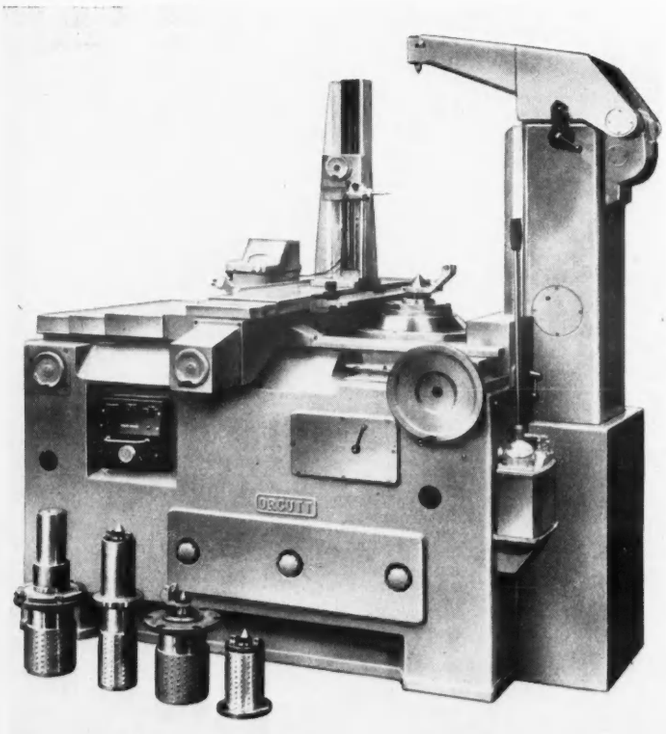


Fig. 48—Individual base circle involute measuring machine to accommodate the type of gears used in the traction field—Gear Grinding

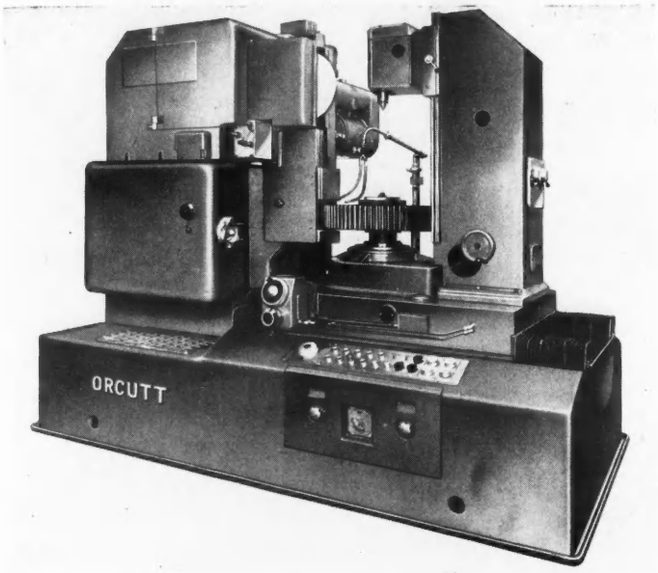


Fig. 50—Grinding machine for traction gears up to 48in diameter and 12in face width—Gear Grinding

and positions repeated to $\pm\frac{1}{4}$ second. It has a 31in diameter platen capable of carrying work up to 1500 lb and can be controlled manually by reference to dial settings or automatically from punched tape.

The equipment uses standard five-hole teleprinter tape, a modified " Creed " teleprinter being used for punching the information on to the tape directly in degrees, minutes and seconds down to $^1/_{10}$ second, eight rows of holes being needed to define an angle. For prototype work, the dividing engine may be controlled from the set of dials with the same order of accuracy as from the tape. The platen may be continuously rotated at a speed of 2 r.p.m. so that the workpiece may set on the platen and " clocked " concentric with the spindle axis. It can also be indexed from information set on dials or " Single Shot " indexing obtained working from punched tape. With automatic index working using punched tape a signal, from some external source, is needed to initiate indexing. The dividing engine can be supplied for use on standard machines; as a complete special-purpose machine programme-controlled with vertical or horizontal boring heads; or as a fully automatic recording gear tooth pitch checking instrument.

The recently introduced " GC48 " gear grinding machine shown in Fig. 50 has been developed for the production of diesel traction gears up to 48in diameter and 12in face width, having from twelve to 240 teeth and a maximum pitch of 1·75 D.P. Large pinion shafts can be ground between the centres of a detachable tail-stock attachment and the maximum diameter of the centre-mounted gears handled is 28in. A hollow workspindle enables long shaft components to be located through the spindle, the maximum shaft diameter accommodated being 6in. The indexing mechanism operates on the same principle as the firm's internal helical gear grinding machine whilst the entire hydraulic system is installed separate from the machine. Machine operation is controlled from one central position and the controls are duplicated where necessary for operating certain units from the rear of the machine. Roller tracks are fitted for both the worktable slide and wheelhead movement. The trimmer unit is of the 1 : 1 form type in which two hardened and ground form plates, shaped to the profile required on the gear tooth, control the path of the diamond tools over the grinding wheel. The root form is produced by a wheel trimmer in which a central diamond is traversed over the complete fillet of the tooth, covering both radii and a flat if required. The radial setting dimension together with the arc of swing to join to the involute curve and the width of flat are all controlled by limit switches and micrometer stops. The accuracy to which this new machine will grind is given as axial alignment 0·0001in per inch face width; involute profile 0·0003in; adjacent tooth space 0·0003in; and cumulative spacing 0·001in maximum.

Acbars, Ltd.

A Liechti heavy-duty chucking automatic lathe shown by Acbars, Ltd., 57A, Holborn Viaduct, London, E.C.1, seen in Fig. 51. It incorporates a steel tape programming unit and is fitted with a 24in power-operated chuck and driven by a 45 h.p. motor. The tools are held in four-sided turrets and the turret slides are controlled by corresponding four-sided template holders which rotate in sequence with the tool holders. The tool turrets, one at the front and the other at the rear of the bed, work independently of each other except that they are timed by the programme control equipment. When turning a large face the two turrets can be combined to work over the area and one cut to blend in with the other. The template units have hydraulic sensing heads and, it is stated, copying to an accuracy of 0·001in is attainable. During operation the turrets are moved transversely and longitudinally through leadscrews by hydraulic motors controlled by the tracing equipment.

A Graffenstaden vertical-boring machine of new design has an integrally cast column and bed designed to impart lasting stability and eliminate need for deep foundations. Its 55in diameter table has a maximum clearance of 51in under the cross rail and is driven by a 45 h.p. motor.

The Alpha vertical-spindle surface grinder to be seen upon this stand has an 8in diameter segmental grinding wheelhead mounted on a column which slides in vertical ways at the rear of the machine. When positioning the wheel it is fed down by hand, but during a grinding operation feed is applied by push-button control in increments from 0·0005in to 0·0025in. The hydraulically-operated 32in by 12in table has steplessly variable speeds up to 65in per minute.

Shell-Mex and B.P. Ltd

The stability tests to which soluble cutting oils are subjected are demonstrated by Shell-Mex and B.P. Ltd., Shell-Mex House, Strand, London, W.C.2. One of the two test rigs on the stand shows the stability of a good quality emulsion and the other shows, by comparison, the effect of a soluble oil having a lower emulsion stability. The tests are related to the recently introduced "Dromus" soluble cutting oils, which contain an improved coupling agent to facilitate the formation of a stable emulsion when the oil is mixed with hard or soft water. The result

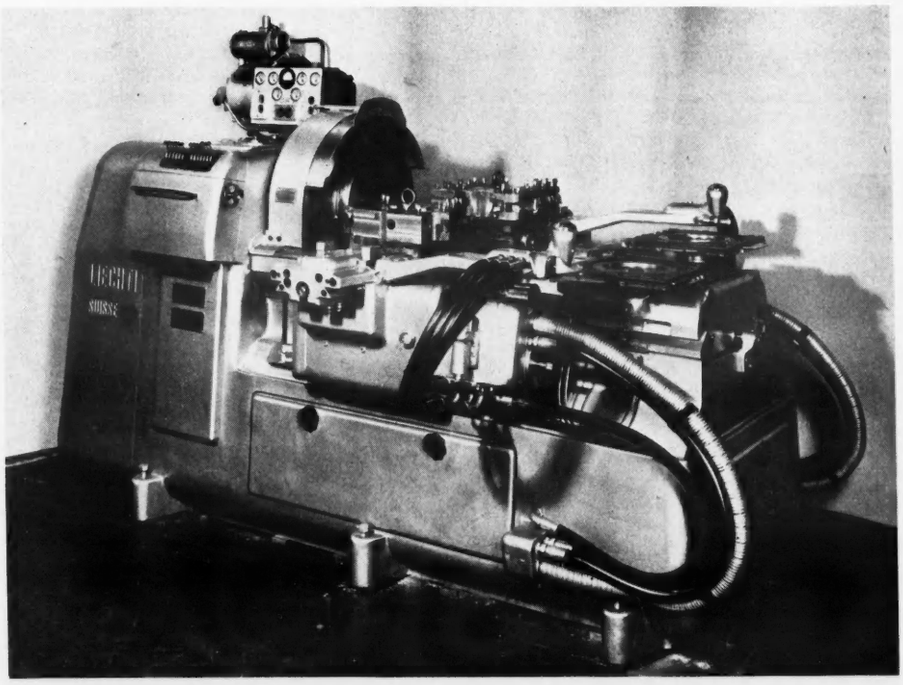


Fig. 51—Heavy duty chucking automatic with front and rear four-tool turrets, programming and copy turning equipment—Acbars

is that the oils do not now possess the odour of disinfectant and since the oils do not have a conventional phenolic coupling agent there is no irritant in the emulsion which might cause skin troubles. These improved soluble oils possess high stability and anti-corrosion properties and a special grade has been developed which can, in certain cases, replace neat cutting oils.

Electric Resistance Furnace Company, Ltd.

The exhibits of the Electric Resistance Furnace Company, Ltd., Weybridge, Surrey, include atmosphere generating equipment, and a new, small size, closed quench furnace, for carbonitriding, gas carburising and hardening processes. The furnace is heated by electric, radiant tube elements operating at mains voltage, and the controlled atmosphere is obtained from a liquid hydrocarbon drip feed unit.

The general design of this furnace, which takes a 14in by 8in by 8in work basket, is similar to that of the larger equipments made

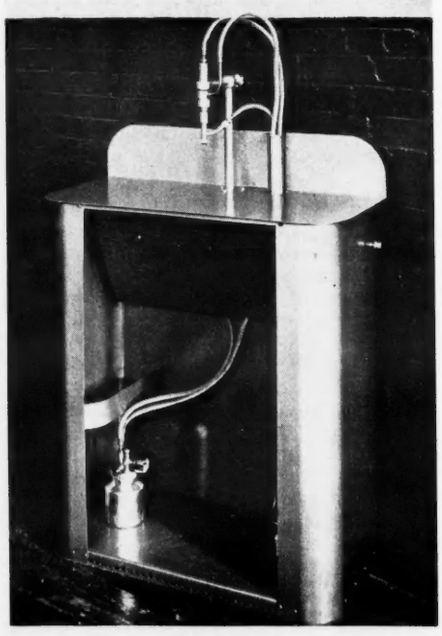


Fig. 52—Brazing paste applicator—Electric Resistance Furnace

by the firm, its outer door giving access to a water-cooled purging chamber and an inner heat-insulated door giving access to the horizontal heating chamber. Both doors are operated by air cylinders and the outer door is fitted with a gas screen. The purging chamber accommodates the single-deck quench elevator used to lower the work into the oil quench tank. The oil is water cooled and is circulated by an electrically-driven agitator. The heating elements are positioned on the walls of the furnace chamber and below the hearth, and a fan, driven by a water-cooled electric motor mounted on the roof, circulates the furnace atmosphere and speeds the heating.

Controlled atmosphere equipment on show includes an endothermic atomsphere generator with an output of only 100 cubic feet an hour, and a mixer for the precision mixing of gas and air for use in atmosphere generators.

A new brazing paste applicator shown in Fig. 52 is a single unit designed to save time, labour and material when applying " Quick-Braze " and other brazing materials used in paste form. It consists of a sheet metal cabinet housing a foot switch, airline and a paste container, and providing a working surface 3ft high. It is arranged for connection to a compressed-air supply and the paste is forced through a nozzle, mounted vertically above the top of the cabinet, by the operation of a pedal.

Soag Machine Tools, Ltd.

The lathes on the stand of Soag Machine Tools, Ltd., Juxon Street, London, S.E.11, include a " Gallic 16 " machine with a centre height of 8in which is made in two models with 40in and 60in centres. This machine, to be seen in Fig. 53, is designed on clean modern lines and has sixteen spindle speeds from 40 to 2000 r.p.m. or 28 to 1400 r.p.m. It is equipped with a pedal-operated clutch by means of which rapid speed and feed changes can be made or the spindle brought to an immediate standstill.

Micrometer stops are provided for both longitudinal and transverse feeds and dials are used for direct reading of longitudinal saddle movements. A Gilly roll turning lathe with 14¾in high centres shown can be fitted with a Heid copying attachment.

The " Elb " horizontal-spindle hydraulic surface-grinding machines handled by this firm do not have compressed tables, transverse feed being obtained from a cross-traversing column in which the wheelhead moves vertically between square guideways. The spindle runs in a preloaded three-point contact bearing with a play of only 0·0004in and is paraffin-lubricated. It is directly coupled to a two-speed motor and forms an integral unit with the drive. A fast cross-feed can be set to operate continuously or in increments up to 2in per table reversal and ensures that the whole wheel face is brought into contact with the work instead of the edge alone, resulting in a fast rate of metal removal and a good surface finish.

The larger models of these machines can be supplied with an automatic cycle downfeed incorporating rapid approach, grinding feed, sparking-out and rapid return of wheelhead to starting position, with subsequent stopping of the machine. This automatic downfeed can be used in conjunction with the " Forster " automatic sizing attachment which sends downfeed impulses through a tracer, until size is reached. In this case the change from rapid approach to grinding feed is controlled by photo-electric cell, and both coarse and fine downfeed is incorporated. The tracer arm is mounted independently of the wheelhead and is set to a given dimension between tracer point and table or chuck face so that the wheelhead descends until size is reached irrespective of wheel dressing and wheel wear.

The rotary table surface grinding machines made by E. and F. Horster exhibited are made in a number of sizes covering diameters of 16in to 40in. On these machines the circumferential grinding speed can be set at a given value and thereafter remains constant, the table speed being automatically varied through a fluid drive controlled by movement of the ram.

A group of machines made by Meyer, Roth and Pastor Maschinenfabrik on this stand includes chain link bending and welding equipment, wire and strip multi-slide forming machines and a universal spring making machine. An Offacine di Ospitaletto machine shown has been developed for the automatic machining at one setting of stampings and castings such as valves and pipe fittings. It has six working stations indexing about a horizontal axis with six independently driven machining heads.

Adcock and Shipley, Ltd.

The milling machines of various types and sizes for production and tool room service made by Adcock and Shipley, Ltd., Ash Street, Leicester, include the heavy-duty horizontal machine shown in Fig. 54. This machine is driven by a 25 h.p. motor and its wide feed and speed range combined with rigidity and ample power units suits it for use with tungsten carbide cutters having either positive or negative rakes and rapid metal removal. It can be supplied in either plain horizontal or universal models. Both models can be fitted with a universal milling attachment swivelling in both planes, and a heavy-duty fixed vertical milling attachment, which is exhibited, transmits the full 25 h.p. of the main motor. The table, with a 72in by 17in working surface, has a longitudinal traverse of 44in, a transverse traverse of 15in and a vertical traverse of 19½in by both hand and power. Twenty-four spindle speeds from 23 to 1250 r.p.m. are available with stepless longitudinal and transverse feed rates from ½in to 64in per minute. A speed and feed calculator built into the side of the column facilitates rapid selection of optimum feeds and speeds and is situated immediately above the spindle speed setting dial.

An interesting contrast with this heavy-duty machine is the latest design of the firm's No. 1 air-hydraulic production milling machine to be seen in Fig. 55. Like the No. 0 machine it supersedes, this machine is equipped with an air-hydraulic feed mechanism by which there can be effected

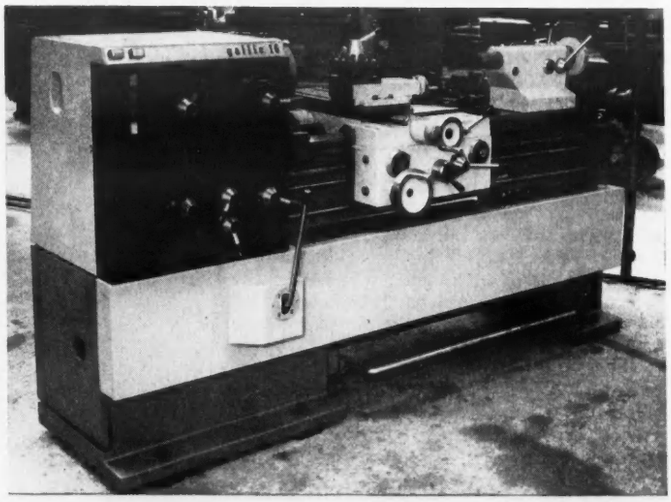


Fig. 53—High speed production lathe with two-position clutch pedal for speed feed rate changing—Soag

a cycle of rapid traverse followed by cut feed and then rapid return to the loading position. Air cylinders built into the cross slide of the table give the rapid approach and return, whilst a hydraulic cylinder mounted centrally between them acts as a dashpot to control the rate of feed during a milling operation. One movement of an air valve starts the automatic cycle. The rate of feed is controlled by an adjustable metering valve, and the length of rapid traverse is determined by adjusting locknuts on the piston-rod of the hydraulic cylinder. The point of rapid return is set by a dog on the table.

On the automatic cycle machine ten feed rates per revolution of the spindle available through pick-off gears range from 0·005in to 0·044in per revolution. According to requirements the machines can be supplied with either of three spindle speed ranges—125 to 1250 r.p.m. with six changes ; 165 to 1650 r.p.m. with twelve changes ; or 250 to 2500 r.p.m. with twelve changes. When supplied for automatic operation the machines are fitted with table having a 19in by 17in working surface and having a 10in longitudinal, a 6in transverse and a 10in vertical movement.

A continuous milling machine for high-production work made by this firm (Fig. 56) has a 26in diameter table driven by a 1 h.p. motor through gearing giving speeds from 18 to 360 r.p.m.—alternative ranges being available giving three-quarters and one-half of these rates. The spindle head is driven by a 3 h.p. motor and the eight spindle speeds are from 45 to 1100 r.p.m. This head, which has a vertical traverse of 3½in, can be swung up to 50 deg. either side of the vertical position. In cases where components can be mounted close together these machines are highly productive, but sometimes the fixturing is such that inevitably there are large gaps between the components which would normally mean wasted time when not actually cutting metal. To obviate this the machines can be fitted with rapid traverse between fixtures, and the machine shown at Olympia is equipped with this mechanism.

The machine is fitted with a 26in diameter rotary table on to which various types of hand-operated, mechanically-operated, hydraulically-operated or pneumatically-operated fixtures can be fitted.

One of the firm's twin column unit head rotary transfer machines is equipped with a six-spindle multi-head and four-station automatically-indexing table for carrying out a three-stage operation on an automobile shock absorber piston. Each of the four stations carries two shock absorber pistons held by toggle clamps. In the first station of the working cycle the components are loaded and unloaded ; at station two, two facing operations are carried out ; at station three the outside diameter of the piston is turned and at station four the outside diameter burnished.

The cycle of the machine is entirely automatic and the drill head advances at rapid traverse rate until just before the tools reach the components, when it automatically changes to cut feed rate for the turning and burnishing operations and then to a slower rate of feed for the facing operations. At the conclusion of the machining, the drill head returns at rapid traverse rate to the top position when the table indexes and the machine recommences its cycle.

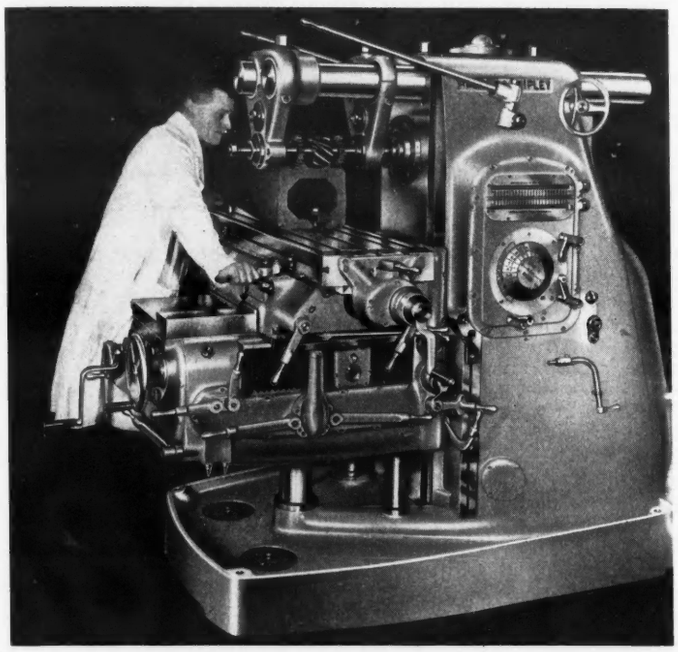


Fig. 54—Heavy duty horizontal milling machine for use with tungsten carbide cutters with positive or negative rake—Adcock and Shipley

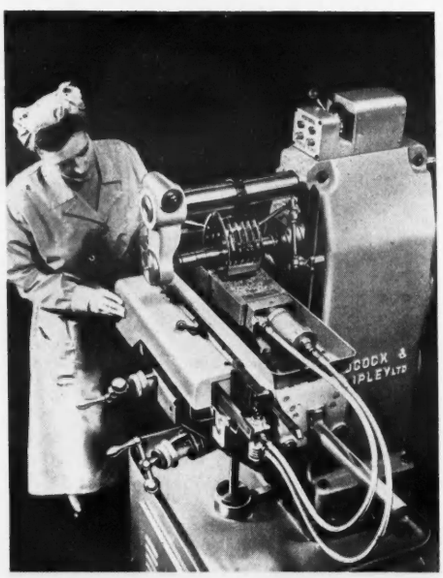


Fig 55—Small automatic cycle production milling machine with air-hydraulic pressure feed system—Adcock and Shipley

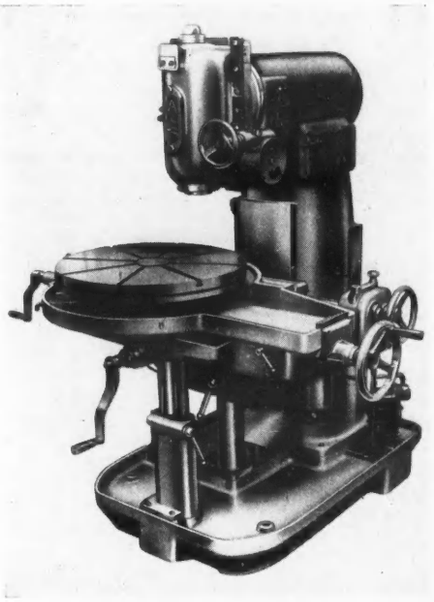


Fig. 56—Continuous milling machine with 26in diameter table—Adcock and Shipley

Ferranti, Ltd.

The co-ordinate inspection machine which provides a rapid means of inspection of machined workpieces to an accuracy of 0·001in is the principle exhibit of Ferranti, Ltd., Hollinwood, Lancs. This machine, which utilises transistorised electronic counting circuits and optical measuring gratings to inspect machined parts by the co-ordinate method, has already been described in our columns.

Basically, the principle employed is to have two freely-moving precision slides, which enable a probe to be moved in either longitudinal or transverse directions between the points on the part to be measured. These slides are fitted with Ferranti diffraction grating measuring systems, which have direct numerical reading making the occurrence of reading errors very unlikely. Relatively unskilled personnel can undertake inspection work with this equipment which enables inspection times to be greatly reduced.

One of this firm's two new and economically-priced machine tool control systems is a continuous system which uses transistors, hydraulic servo-mechanisms and a simplified means of measuring. The other system is an equipment designed for rapid point-to-point positioning of machine tools and allied equipment in Cartesian or polar co-ordinates.

Examples of these systems can be seen on a Kearney and Trecker milling machine controlled on three axes exhibited on the stand of E. H. Jones Machine Tools, Ltd., and a Hayes/Ferranti " Tapemaster " on the stand of Hayes Engineers (Leeds), Ltd. An H.P.E./Ferranti " Contourmatic " two-dimensional profiling machine fitted with Ferranti control equipment exhibited on the stand of High Precision Equipment, Ltd., is intended for the machining of such parts as templates and cams. It is also available with continuous control in the vertical axis and increased vertical height capacity, for the production of three-dimensional components.

British Ermeto Corporation, Ltd.

We illustrate in Fig. 57 one of a new range of balanced stop valves introduced by the British Ermeto Corporation, Ltd., Maidenhead, for use on hydraulic systems up to 8000 lb per square inch pressure and pneumatic systems up to 5000 lb per square inch

Fig. 57—Fully balanced stop valve with Ermeto ends for hydraulic and pneumatic pressure pipe systems—British Ermeto

pressure. These valves can be supplied in mild steel, high-duty bronze or stainless steel and are available for use with nominal bore piping from ¼in to 1½in diameter when fitted with Ermeto ends as shown. When fitted with B.S.P. female end connections they are suitable for ⅜in to 1¼in systems and special end connections can be effected using steel couplings or adaptors.

These valves are fully balanced and have non-rotating spindles with non-rising handwheels. They are fitted with replaceable nylon seats and both spindle and sleeve sealing is by synthetic rubber "O" seals.

Newman Industries, Ltd.

A fully-operational standard 10-cwt motorised hoist unit fitted with a brake motor and an electronic timing device to measure the effectiveness of the brake is the main feature of Newman Industries, Ltd.

The electronic equipment demonstrates the stopping time of a Felco hoist and so the efficiency of the brake. The Newman brake motor, introduced by the company last year, incorporates an electro-magnetic disc brake and the range covers from fractional to 40 h.p. units. Exhibits on this stand emphasise the machine tool applications of the company's electric motors with particular reference to the newly-developed range of brake motors. Selected items of customer's equipment actually operating include a Kitchen and Wade unit head with a fast traverse mechanism and a Brooke unit head, each powered and controlled by a brake motor.

Newage Machine Tools, Ltd.,

A small high-speed milling machine for the production of small precision parts made by Newage Machine Tools, Ltd., 98-100, Croydon Road, London, S.E.20, uses small diameter tungsten carbide milling cutters or grinding wheels. This machine (Fig. 58) has a ½h.p. spindle head with a variable speed range up to 45,000 r.p.m. mounted on its column up which it has a vertical adjustment of 3½in. The head can be tilted up to 45 deg. on either side of the vertical centre line and swung through 360 deg. on its slide. A 12in by 4in table is arranged for air-hydraulic feed up to a speed of 70in a minute under electric push-button control.

A multiple set-up of the firm's "Precise Autodrills" is designed to show how this design of fully-automatic drill head can drill holes up to $\frac{5}{16}$in diameter in mild steel at 2in centre distances when driven by a single motor. In these units air is used for advancing and retracting the drilling spindle, whilst hydraulic fluid controls the infeed. A double cylinder design giving power three times that of line pressure provides ample thrust for drilling operations. Hydraulic infeed is continuously variable up to 120in per minute, which permits breakthrough without drill breakage. A precision depth control to the spindle facilitates automatic retraction within a stated 0·001in. of pre-set depth. The "Autodrill" may be connected to cycle continuously or to give individual cycles by a push-button, foot switch or fixture interlock. Separate interlock terminals are provided to inititate operations or index rotary tables.

Masson Seeley and Co., Ltd.

The efficient marking of parts and materials is an essential factor in the engineering industry and a number of special machines for this class of work have been developed by Masson Seeley and Co., Ltd., 137-139, Euston Road, London, N.W.1. To show the wide field of industrial applications for these machines the firm is exhibiting marked specimens in a variety of materials, including steel, aluminium, iron, zinc, copper, plastics, acetate, rubber, leather, wood, &c.

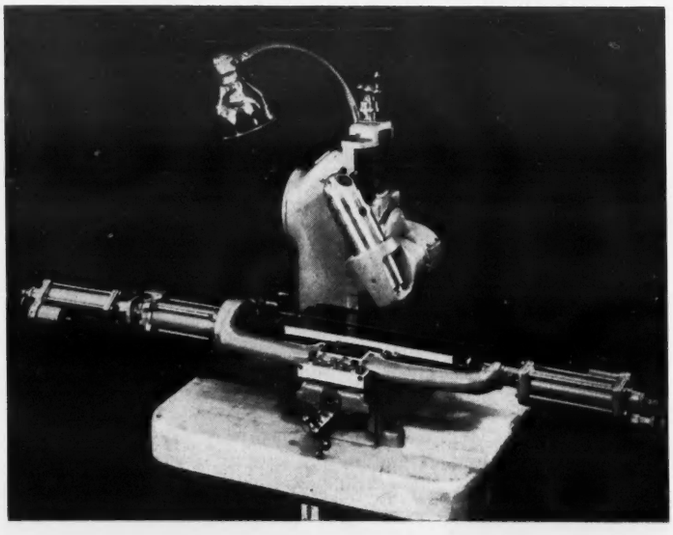


Fig. 58—High speed milling machine for the production of small precision part—Newage

A recently introduced machine exhibited operates automatically on a rotary principle at speeds up to 1200 pieces an hour and will apply marking round the complete periphery of circular or tubular objects. Another machine is capable of applying two colour marking in accurate register and in only one feeding on such things as industrial belting, ribbon, leather and plastic articles.

B. and S. Massey, Ltd.

Six machines from the range of forging and drop forging equipment of B. and S. Massey, Ltd., Openshaw, Manchester, to be seen at Olympia, include the new 100-ton "wide ram" press for trimming and setting operations, illustrated in Fig. 59. This design of

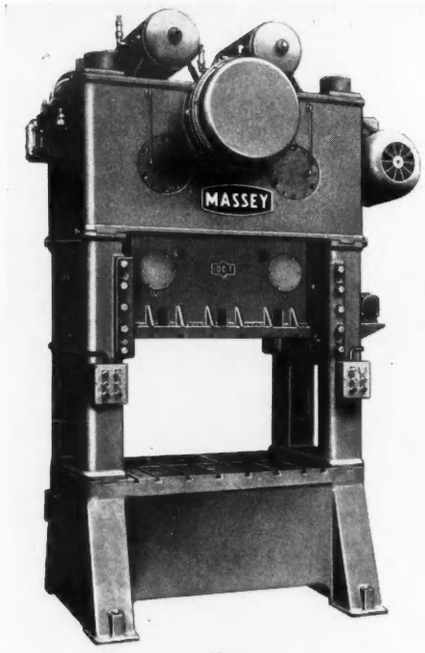


Fig. 59—100 ton "wide ram" press for trimming and setting.—Massey

press is made by the firm in capacities from 100 to 1000 tons and with table working areas of from 46in by 30in in the smaller size to a maximum of 84in by 50in. Each press is provided with four one-piece cast steel pitmans, thus ensuring the maximum resistance to tilting of the ram. A direct, air-operated, friction clutch is fitted and a lubrication unit is automatically interlocked with the main press drive so that when the press is in operation, adequate lubrication is provided for all moving parts. These machines have a welded box-design frame incorporating the bedplate, uprights and crown, the complete structure being held together by four large diameter bolts shrunk into position.

The 1000-ton high-speed forging press to be seen has been designed to stand up to severe three-shift working conditions for long periods at high production speeds. Its air-cooled friction clutch is mounted on the eccentric, and the parts to be set in motion and stopped at each stroke are of low inertia so that power consumption, heating of the clutch parts and shock to the frame are reduced to the minimum. The ram and pitman assembly of the press is dynamically counterbalanced, the pressure in the air balance cylinders rising as the ram approaches the bottom dead centre of its stroke. All movements of the press are controlled by one central push-button panel.

(*To be continued*)

Machine Tool Development and The National Economy

In presenting the 1960 *Viscount Nuffield paper to the Institution of Production Engineers on Monday, June* 27, *Sir Stanley Rawson dealt with the subject of machine tool development and national economy. The first parts of this paper generally traced machine development and the way in which war and the demand for armaments accelerated and promoted development. The abstract which we reproduce below has been taken from the second half of Sir Stanley's paper.*

IT is interesting to recall the difference in psychological outlook which resulted from the war of 1914–18. Up to that time, the machine tool was a device which merely extended the skill of the skilled man. During the war the machine tool became what it has since remained, an instrument of production, and every development of it has been to improve the yield and accuracy of its work. What we may describe as the finer machines, the milling machine and the internal grinder, owe their growth to the demand for time fuses during the 1914–18 war ; and from that war stem also the multitudinous devices for automatic or semi-automatic operation of the slides and cross slides of machines and the indexing mechanism of the capstan. None of these would have come into being without previous improvements in the accuracy and durability of gears. The invention and production of ball roller bearings, with the work of Palmgren and Hoffman, solved many difficult problems of bearing sizes, and housing dimensions were solved.

Perhaps the most significant revolution in the conditions surrounding the advance of the machine tool was the standardisation of the frequency of electricity. Without that, the built-in standard drive would have become hopelessly complicated. This indeed was one of the most difficult problems of production during the war of 1914–18 ; in marked contrast to the second world war, the problem of the location of war industries was greatly simplified.

To no small extent production methods and the machines to apply them were retarded by the severe economic depression of the early 'thirties ; but as the country emerged from it, the ideas and conceptions pioneered in this country by Lord Nuffield began to take form and shape. The specialist maker of components emerged and the automobile industry began to assume the shape it has to-day. A whole new family of machines came into existence to meet this demand, designed for easy feeding, much higher speeds and easier clearing and much more powerful than the generation which preceded this period. There was still a tendency on the part of some builders, especially of centre lathes, to underpower their machines. Many users had already reached the conclusion that a machine tool was intended to be driven hard and drove them hard with outstanding success. It was as well they did for new cutting media were on the way, capable of far higher cutting speeds but requiring much finer feeds with a minimum improvement of machining times of upward of 25 per cent. This applied both to cutting tools of cemented carbide and the synthetic grinding wheels with carefully controlled gramme sizes ; and both suffered from the same disability that barely 15 per cent of the machines in general use could employ them even to one-half of their inherent capacity. They were relatively fragile and were ill-regarded in many shops as the harbingers of cutting of piece-rates. Their ultimate effect was to render obsolescent a large proportion, probably something like two-thirds, of the machine tool population of the country.

Simultaneously another change was in progress, namely, the increasing use of aluminium and its alloys in aeroplane construction. The machining of aluminium, especially the durals, presented machinery problems of a curious kind, and only by trial and error did it emerge that these metals could be cut at four times the speeds used for ferrous metals, and also required special designs of cutters for the best results. Further, extremely high speeds were needed. Quite a number of good-class milling machines could not match the speeds required and very few lathes could get the power needed.

It is probably true to say that no country in the world produces every type of machine which its industry even in normal peace-time conditions requires. There is no trade in which there is a greater interchange of types of machine than the machine tool trade ; and none which reflects more clearly the sort of industrial pattern which each particular country enjoys. The maximum war demand is for the fringe sizes of machines both large and small, together with a great increase in the means of producing jigs and fixtures and building prototype components on very accurate machines. The economy of Great Britain in 1952 was directed principally to the recovery and maintenance of the export trade ; and a vital decision had to be made whether to swing over to war production the whole of the machine tool industry at home, or to devote a considerable proportion of the country's overseas earnings to the purchase from other countries of much of the conventional machine tool equipment required. The defence programme of the three services called for about 54,000 machines, apart from the demands of normal industry for replacement. The British machine tool industry could produce—apart from a number of small general purpose machines—about 60,000 machines a year, of which some 24,000 went into the export market. An embargo on export would have meant the sacrifice of many traditional markets both inside and outside the Commonwealth ; and the decision was taken to continue exports with the minimum of interference and to purchase from West Germany, France and Italy about 36,000 machines to supplement what could be taken from home industry. The remaining machines, about 18,000 in all, came from the U.S.A. Most of these were critical machines and were delivered in about two years, and by far the greater number from Mutual Aid Funds.

New Cutting Media

The invention of new cutting media again bids fair to make obsolescent before their time many machines of almost exquisite ingenuity. The several types of ceramics, chiefly sintered alumina, enable cutting speeds of 3500ft to 4000ft per minute to be attained on centre lathes turning steel plate mill rolls or heavy propeller and intermediate shafts. Such lathes need 150 h.p. or more to drive them and can handle four or five times the amount of work handled by a normal machine. Large vertical boring mills, heavy-duty face-plate lathes, plano-millers with more powerful drives can well benefit from these tools. But these machines are long-lived and very rarely end their working life. Their entry into industrial life is either upon an occasion of emergency or upon some programme of concentration of production when time is of the first moment. The appearance of new cutting media, and of new materials of construction to be cut, is to-day a good deal more frequent and faster than the response of the machine tool designer to them. This is quite natural, since many of these new materials need quite new techniques for their application. At the other extreme, new cutting methods have greatly reduced both the cost and the risks involved in the preparation of such items as tools for drawing presses and for gravity and pressure castings. It is now practicable to cut and shape these tools in the fully hardened condition either by electro-erosion or supersonic means and some progress has already been made in the use of electronic cutting. The attraction of these processes is the relatively simple design of the machines needed ; they are revolutionary without being subversive !

The development of modern industry now depends upon mass demand and the means of satisfying it. The machine tool has become now a twofold instrument. In one aspect, it remains what it always was : the indispensable instrument for making component parts of industrial equipment ; in its other aspect it has become the indispensable instrument for making quickly and accurately the component parts of a multitude of quasi-consumer goods. It is perhaps fair to say that there is already in process a dual line of development ; the distinction between them is as yet not fully defined and will naturally depend upon the shift of emphasis even within a single firm's production. In what I have referred to as the first aspect, the machine tool industry is tending towards the control of the machine otherwise than by the operator. Tracer control of a lathe or milling machine either from a template or from a master had already been well developed in the late 'forties, and was a valuable mode of repetition production, even of small quantities. But the original master had to be produced by a skilled man either on a lathe or milling machine, or even on a jig-mill. At least one automatic factory existed some eight years ago, when standard machine tool components were machined on remote controlled machines. Tracer control is now tending towards numerical or magnetic tape control of machine with pre-set timing. These devices are similar in principle to the automatic lathe, whether single or multi-spindle. In these latter tools a change of product means a change of set up ; in the tape or electronically-controlled machine, the machine's motions change in direction and duration as the control mechanism demands.

Both types demand great accuracy and great rigidity in the machine structure and great durability in the cutting medium, with quite a problem in the matter of the lead-in to the workpiece. The cost of machines of this character seems to compel the concentration of many functions within one main framework, and they have the disadvantage of being relatively inflexible when dimensional

or design changes come about. The other series of machine tools is more specifically of those installed in the many production and feeder lines which are needed to satisfy mass demand. Here the machines are predominantly single-purpose machines ; but even their installation means an expenditure of hundreds of thousands of pounds.

The Problem of Change

Here the problem of change may be met by changes in tooling ; but quite often this amounts to a third or more of the cost of the machine. Apart from the automobile industry, many mass production lines consist of relatively small machines. Even on these lines the production process has a high degree of rigidity, and changes in design or materials used can involve serious expenditure and what is commercially worse, very much loss of output. In the past this problem has been met by deliberate over-production on final runs, especially in domestic equipment lines. The surplus is sold at cut prices. With the growth of competitive demand this is only an expedient ; but the increasing cost to industry of the unexpired life of production lines has brought into being two separate but related trends. First, the development of which Renault were the pioneers, the unit head and the building of machines on the "Meccano" principle ; and, secondly, there is going on serious research into the simplification of the machine-part of the machine tool, into the building of interchangeable sections of the bases and columns of machines to make them adaptable or the setting of different tables and "arms" of wheels as tools. Both these trends are of real importance, partly because they represent a serious attempt to overcome the rigidity implied in the tailor-made machine and partly because they will help to balance the appalling problem of the hills and valleys in machine tool production.

I have refrained from using statistical illustration. In the first place statistics of the numbers and types of machine tools are extremely misleading ; and in the second place, the definition of machine tools is so inexact as to make other than very broad comparisons impracticable. The massive demands of two actual and one threatened world conflicts for small arms for millions of men, for the construction of military, naval and aerial weapons and their transport and servicing have, in fact, transformed the machine tool from its original purpose as an instrument of production into a factor in strategic logistics as fundamental as the study of available man-power. It is studied by politicians and their advisers as an element of actual or potential military strength and in that view its flexibility and its capacity for expansion are regarded, and in that sphere of thinking quite rightly regarded, as appropriate qualities to be studied.

Planning for Expansion

Quite obviously in every industry there always exist a number of means of expansion, especially if the expansion is in certain limited types ; but this probably does not exceed something of the order of 10 to 12½ per cent overall. A further expansion needs longer range planning and in general is only practicable by bringing into machine tool production a number of industries whose product is akin, such as manufacturers of printing machinery, of material handling plant, knitting and weaving machinery. A secondary but similar stage is the duplication of existing plants. The problem here is not the installation of plant but the provision of the several jigs and fixtures indispensable to the operation of the plant. These very rarely exist in duplicate or even in detailed form ; shop modifications impose all sorts of minor but significant differences. The almost natural reaction to these problems is the creation of the so-called strategic reserve. Experience shows how dubious is this policy. Even in temperate climates slides and surfaces corrode ; lubrication cannot be maintained and the man-hours needed to bring to working order a machine stored even under ideal conditions is too extravagant to be tolerated.

It must always be realised that change—and imperceptible change—is continuous and its extent is only realised when, for example, you undertake the rebuilding of machines which have already done much service. It is part of human frailty that what goes to strategic reserve is not the desirable but the less desirable machine, and by the time the less desirable machine is needed it is even less desirable. There has quite recently been a notable illustration of this in the very well-intended release from the U.S. strategic reserve of machine tools by way of economic aid to certain Eastern countries.

I have referred to Professor Melman's Report which is only so far known in outline from his précis as delivered on television and radio. The Report of the Committee of D.S.I.R. is not yet available ; but there is little doubt that it will seek to indicate some systematic view. The misfortune of systematic views is that they are valid only for a particular set of circumstances envisaged as desirable for an assumed or explicit policy. This may be strategic or economic ; both may be completely at variance with commercial need. Machine tool builders are not philanthropists nor can they afford to build expensive prototypes with no visible future demand. Machine tools are instruments of industry and exist only in so far as they make practicable the manufacture of a wide range of components. They have to be modified as the means of cutting and shaping alter, as the scale of the components or the materials composing them change.

It is a not uncommon conviction on the part especially of Governmental departments that the size of an organisation is a prima facie condition of its efficiency. The machine tool industry in Great Britain covers about 350 to 400 firms ; in the U.S.A. there are about 250. Here again we are faced with problems of definition.

There has been in progress during the last five years a consolidation of machine tool makers in the U.S.A. and on a smaller scale in this country ; but there has also been an increase in the number of tool-making firms whose products are often hard to distinguish from machine tools. Partly this is a social phenomenon somewhat similar to the growth of the electronics industry, built up by small independent groups of specialists as well as by the research organisations of the larger electrical firms. Some of these coalesce into larger units with a standardised basic production and an effervescence of fringe products. That is precisely parallel to the growth of the machine tool industry. The average age of the machine tool population of Western Europe and the U.S.A. is about ten years—half of it about fifteen years and half of it five ; the five-year group is the group of high production machines mostly in the automobile and allied industries ; and the proprietors of these machines would like to lift the average to something like seven or eight years. This should be quite a practicable aim if the bases and drives of many machines could be suitably standardised to take a number of diverse tool-holders and tool-settings.

This, of course, raises the whole problem of the reasonable limits to which machine tools should be built. Quite a number of tentative proposals have been made, of which the most comprehensive was that of Dr. Schlesinger. It has proved in international negotiations an extremely difficult task to arrive at agreement upon what tests should be applied to a machine tool. It is unfortunately true that a machine tool built of carefully gauged components may not be a good machine tool ; it should be, but in practice it often is not. Equally, there are very few machines which cannot be made to perform more accurately by careful reassembly. It is also generally accepted that a reasonable standard machine may in the course of its working life have to deal with a number of materials presenting more or less difficulty. Usually they do this quite satisfactorily. For specialised machines such as single and multi-spindle autos, the only valid test is the ability to produce a range of products at a timed speed. So many machines are, however, purchased to-day to machine specified pieces within specified limits that the older practice of shop limits is really no longer tenable.

Guarantee of Compliance

Within the European Common Market there is no doubt whatever that machine tools will carry a guarantee of compliance with specified geometric requirements. The Russians do this already. It has been their practice to dismantle a machine into its component parts and examine every sub-assembly in detail, making copies of each one. It is an expensive process in man-power but far less expensive than creating working drawings and translating them into a different measurement system. A similar method was used in this country for certain specialised aero components and will no doubt be used again.

The machine tool industry is an instrumental industry and it is international. It embodies the brains of designers who study the most economical way in which metals, wood and synthetics may be shaped internally and externally ; it adapts its products to the techniques of other industries ; for example, the radial drill was the adaptation of the drill to boiler shells and structural steel. It had to solve many problems of vibration before they were known or appreciated in general engineering. It has moved with the advance of metallurgy. No country has at all times produced all the machines it needed for its own industries and the development of machines has, in its turn, depended upon the specific types of engineering equipment to which the machine was a specific response. The design and building of the large horizontal borers arose from the demand of the builders of heavy rolling mill plant ; for the large vertical boring mills from the demand for water turbines and later for the casings of high powered steam turbines ; the heavy milling machines with their spacious tables were the outcome of demand of the aero-engine and aeroplane industries.

A number of these complex machines suffered from the fact that they were "blown-up" from smaller models ; and they were anything but easy to feed or unload and suffered from a lack of "get-at-ability." Successful machine tools must fit into a general pattern of systems of production ; and the endeavour to require that every machine must be tailored to fit an individually desired system is wholly uneconomic.

LETTERS AND LITERATURE

Letters to the Editor

STRUCTURAL STEELWORK

SIR,—The article in your issue of April 22 by Mr. A. N. Procter on " Rules and Regulations for Structural Steelwork " contained the astonishing statement that " The year, 1959, however, marked the passing of the control of the design of structural steelwork entirely into the hands of the British Standards Institution ; so that there is reduced hope of any reasonable future progress in this branch of British engineering." It is true that in 1959 a revision of B.S.449, *The Structural Use of Steel in Buildings*, was issued. This standard has however been in existence for nearly thirty years and there is no more " control " of steelwork in the hands of B.S.I. now than at any time in the past.

In point of fact, no control whatsoever attaches to this British Standard—nor indeed to any British Standards at all. Local authorities and others concerned may, in their wisdom, decide to require that steelwork should comply with the British Standard—but such action is in no way the responsibility of the B.S.I. committee concerned. That committee is constituted of expert representatives of all the various interests concerned with steelwork who give freely of their time to draught what they consider to be a good standard. This having been done and the standard issued they can exercise no control whatever in the adoption of the standard.

The very fact that the 1959 edition of B.S.449 represents the fourth revision of this standard is in itself evidence that the existence of the standard does not inhibit progress in this branch of engineering. Indeed, many have publicly welcomed the new edition of B.S.449 as opening the doors to further advances in this field.

G. WESTON,
Technical Director
British Standards Institution,
2, Park Street, London,
June 15.

SELF-INDUCED VENTILATION OF ROAD TUNNELS

SIR,—The paper " Self-Induced Ventilation of Road Tunnels " (THE ENGINEER, June 24, 1960) contained valuable information on this subject. It would seem that the necessity for forced ventilation plant is proved by the comments contained in the last paragraph of the paper prior to the conclusions. It is interesting to note that diesel engine exhaust smoke as well as CO is discussed at this point. The experience in the Scheldt tunnel, through which big transcontinental diesel lorries pass, confirms the necessity for some indication of smoke concentration as well as CO monitoring.

In my experience, forced ventilation in such tunnels has always been accepted as necessary, but the most economic means of achieving it has been the subject of some debate. However, to initiate control, whether manual or automatic, some form of virtually instantaneous indication of CO and smoke density levels is essential.

A. ELLIS HOULT
Wallington, Surrey,
June 27, 1960.

CONTROL OF WATER RESOURCES

SIR, As an angler, as well as an engineer, I should like to congratulate you on your leader, " Control of Water Resources," in your issue of May 27.

Not only have River Boards, to my mind, acted unwisely in their merciless dredging, but also the building of metalled roads on Dartmoor and other moors, as well as drainage schemes, have isolated or removed vast reservoirs of peaty bog which used to hold water and release it slowly, in much the same way as the chalk. Now these areas suffer alternating floods and low water.

With regard to pumping by commercial firms, I know of one estate where this has contributed to a fall in the local water panel of something like 10ft in twenty years and here again floods are not infrequent due to the enormous amount of surface water now shed into inadequate drains from a large area of roofs and concreted yards where in the past gravel soil quickly absorbed the heaviest rainfalls, which, of course, helped to maintain the water panel.

I am the more bitter about this in that it has caused the virtual drying up of a lake wherein I once got thirteen pike, spinning, in 2½ hours on a New Year's Day.

The conservation of such water as is available seems a matter for legislation, for many industrial concerns use large quantities of water for cooling purposes and run this straight into the drains.

My wife once passed the morning paper across to me with the caustic remark that she did not think much of engineers. The paper contained two separate paragraphs, one reporting flooded roads, while in a shortage area water was being carted to villages !

L. J. CARDEW WOOD
London, E.C.4,
June 16, 1960.

LAST SOUTHAMPTON PADDLE STEAMER

SIR,—The author of the short article under the above heading which appeared in your issue of June 10 is incorrect in referring to the " Freshwater " as being the last paddle steamer at Lymington. The " Farringford," which entered the service shortly after the end of the last war, is propelled by independent paddles, diesel-electric driven and bridge controlled.

J. H. JELLETT, O.B.E., M.I.C.E.
Southampton,
June 16, 1960.

Book Reviews

Advanced Structural Design. By CYRIL S. BENSON. B. T. Batsford, Ltd., 4, Fitzhardinge Street, Portman Square, London, W.1. Price 50s.

THIS is a practical book which assumes that the reader is familiar with the standard methods of analysis. It is primarily intended for the use of structural and civil engineers, and will prove a useful basis for those studying for the Associate Membership Examination of the Institution of Structural Engineers.

The book comprises seventeen worked examples, each being analysed, designed and partially detailed. The calculations are presented in a clear and concise manner, the numerical work being augmented by description wherever necessary. There are, as is natural in a practical book, many simplifying assumptions ; more emphasis could have been placed on these assumptions, so that the reader is fully aware of the implications involved. There are examples of steel and reinforced concrete water towers ; steel and reinforced concrete coal bunkers ; a concrete silo ; a simply supported steel bridge ; a brick chimney ; 120ft weaving shed ; two-bay steel portal ; a reinforced concrete-framed office building and other structures in steel and reinforced concrete. The author quotes passages from the codes of practice when and as required, but gives no references to papers or articles on similar projects to those being described.

The book should prove of great help to all those graduate engineers faced with their first design problems in the office and to those who have specialised in one sphere and wish to broaden their outlook.

Books Received

Nuclear Power Year Book, 1960. Edited by W. Caldwell Davidson. Rowse Muir Publications, Ltd., 3, Percy Street, London, W.1. Price £2 12s. 6d.

Symposium on Shaft Sinking and Tunnelling. Proceedings 1959. The Institution of Mining Engineers, 3, Grosvenor Crescent, London, S.W.1. Price £3 2s.

Handbook on Electroplating. Nineteenth Edition. *Polishing, Bronzing, Lacquering.* W. Canning and Co., Ltd., 77, St. John Street, Clerkenwell, London, E.C.1. Price 30s.

Principles of Servomechanisms. By A. Tyers and R. B. Miles. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 25s.

The South African Mining and Engineering Year Book, 1959-60 (Golden Jubilee Issue). Argus South African Newspapers, Ltd., 85, Fleet Street, London, E.C.4. Price 84s.

Electrical Noise. Fundamentals and Physical Mechanism. By D. A. Bell. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 50s.

Space Flight. Vol. 1. Environment and Celestial Mechanics. By Krafft A. Ehricke. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price £5 9s.

Hydraulic Handbook. Second Revised Edition. Compiled by Editors *Hydraulic Power Transmission.* Trade and Technical Press, Ltd., 1-9, Tudor Drive, Morden, Surrey. Price £5 10s.

Economic Control of Interconnected Systems. By Leon K. Kirchmayer. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. John Wiley and Sons, Inc., New York. Price 100s.

Economic Aspects of Fuel and Power in British Industry. By The Manchester Joint Research Council, Manchester University Press, 316-324, Oxford Street, Manchester, 13. Price 25s.

MAINLY METALLURGY

by T. Henry Turner, M.I.Mech.E. M.I.Loco.E. A.R.Ae.S. F.I.M.

Aluminium Alloys in Railway Rolling Stock

THE lecture room at the Institution of Mechanical Engineers was full for the recent symposium on the use of aluminium in railway rolling stock (See THE ENGINEER June 3, 1960, page 946), showing that much interest had been stimulated in the subject.

Further development of the use of aluminium alloys in railway vehicles has become possible because:—

(1) The aluminium industry now achieves a yearly production which is six times that available in 1939.

(2) The techniques for manipulating aluminium alloys are different from those learnt for iron and steel ; this is now better known and the new techniques have been much improved.

(3) More robust sections of aluminium alloys are now in production and designers have by now made the essential change of mind from thinking only in terms of the thicknesses used in the early metal aircraft.

(4) Welding techniques for aluminium alloys have been developed in reliable workshop processes.

(5) Frameless designs of railway coaches are now challenging the attention of designers. Such vehicles as the mass produced, Swiss designed, Indian built integral coaches are breaks with the traditional methods and open up the possibilities of corresponding breaks with the traditional materials of construction.

Up-to-date information regarding the magnitude of the raw metal production in the world, the range of tested and standardised alloys now in use in Great Britain in the form of castings, extrusions, or otherwise wrought by hot or cold work, also their physical and mechanical properties, corrosion resistance, and working methods, were all given in a paper specially written for the occasion by the Director of the Aluminium Development Association. This paper on the properties of aluminium will be useful to metallurgists and engineers responsible for the selection of materials, but it was not presented at the symposium for discussion. In an appendix it gives the British Standards Numbers and dates for aluminium and aluminium alloys and explains the system of nomenclature. A convenient way of following the various aspects of research and technical progress in aluminium and its alloys has been provided by the summaries written during each of the recent years by E. Elliott. These include hundreds of references and have been made available by the A.D.A. as reprints.

Design Aspects

The general aspects of design in aluminium alloys were covered informatively in the paper by J. F. Thring, who used as illustrations coaches on the L.T.E., East African Railways, Toronto Transit Commission, and German Federal Railways as examples of passenger vehicles. He also showed aluminium hopper wagons of the Morrocan Railways and aluminium refrigerator cars of the Canadian National Railways.

Mild steel or low-alloy steels have been the natural choice of designers up till now, the higher price being the first and greatest obstacle to the use of aluminium. The second obstacle has been the inability of designers and railway operators to make reliable, scientific evaluations of the commercial gain through saving weight in railway vehicles ; except for vehicles used on intensive city passenger services employing electric traction.

Designers require more evidence as to the importance of preventing the corrosion of aluminium. If a suitable alloy has been chosen for use in a railway coach, little allowance is needed on the thickness of panels and sections to meet corrosion in service, as is the accepted practice with steel structures. Nevertheless modern design tends to reduce the factor of safety in the search for bigger load/tare ratios, and corrosion fatigue becomes the form of failure in service against which preventive measures must be taken. the reassurance given by laboratory fatigue tests in warm dry air should only be accepted if they are matched by correspondingly good figures for fatigue resistance under the polluted, moist atmospheres of service conditions. Hence it may well be that, following the lessons which have been learned with steels, the protective painting of aluminium alloys subjected to high repeated stresses will still be desirable. One must remember that a steel railway coach axle, and especially a steam locomotive tender axle, will quickly fail in service by corrosion fatigue if not protected by paint, but it will serve for many years under identical conditions without failure if correctly painted and repainted, so as to exclude the corrosion factor of the corrosion-fatigue.

Progress in the design of aluminium alloy rolling stock has been aided by the increasing appreciation of the scope afforded by the extrusion process and by the variety of features available in the wide range of standardised commercial alloys.

New welding techniques for aluminium alloys will play an increasing part ; especially the commercial introduction of the fine wire consumable electrode (MIG) equipment. This can be used to make large items such as body sides, roofs, and body ends. Here it must be noted that such large components cannot be heat-treated after fabrication, so that non-heat-treatable alloys become the obvious choice ; their fatigue resistance being normally comparable to those of the higher U.T.S. heat-treated alloys.

Professor D. N. de G. Allen and D. W. Windle made no especial reference to aluminium in their application of numerical methods in the investigation, by means of a Ferranti " Pegasus " computer, of the distribution of stress in a railway coach frame. The coach selected as an initial example for the illustration of their methods was one built by Messrs. Metropolitan-Cammell for the Indian State Railways.

Sir Alfred Pugsley, F.R.S., showed by means of lantern slides a series of tubes which he had tested in the laboratory. Under compression each of them had failed progressively from one end by one or other form of crumpling. This proceeded from one end of the tube as a series of energy absorbing locally severe plastic deformations without tearing. He then applied these observations to the practical problems of designing a railway coach so that on accidental severe impact in an end-on collision the minimum damage would be suffered by passengers. He thus thinks of a passenger coach as a very large sectioned tube, the middle portion of which may remain under bearable stress while the end is absorbing the impact energy by the plastic deformations of crumpling. If the ends of railway vehicles are designed to crumple rather than tear, lives may be saved and injuries minimised.

Mr. S. White, technical director of Cravens, Ltd., showed many examples of the use of aluminium in the construction of railway vehicles. He said that to compete with other forms of transport, new designs of rolling stock should provide a reduction in tare weight. The information which he gave in his paper should help to make light alloy vehicles more competitive with all-steel construction. This applies also to two aluminium containers developed for British Railways, which he illustrated.

The container developed by Tube Industries, Ltd., has sides and ends built from special extrusions joined by " Araldite " resin adhesive, thus saving weight and costs as compared with argon arc welding. The container developed by the Northern Aluminium Company, Ltd., has a composite construction using about ½ ton of aluminium and ½ ton of steel, and should carry 5 tons in 500 cubic feet.

Experience in Service

Mr. A. W. Manser, C.M.E. (Railways) of the London Transport Executive, described experience with subway rolling stock. It was in 1948 that the L.T.E. decided to purchase ninety light alloy vehicles for the District Line, and the first of them was put into service in May, 1952. So Mr. Manser could speak on the basis of eight years of intensive service, and that led him to conclude that the L.T.E. intend to continue with the introduction of vehicles generally of light alloy construction in the case of the so-called " surface " lines, where a straight underframe makes the use of light alloy extrusions practicable, and with the composite vehicle of steel underframe and structure, but light alloy panelled for the smaller " tube " type vehicles. He summarised the advant-

ages to be gained in this manner as (1) saving in energy consumption ; (2) reduction in corrosion damage ; (3) economy in painting costs.

Mr. A. E. Robson, C.M.E. (British Railways), L.M. Region, had written his paper on the basis of practical experience gained since 1952 with British Railways light-alloy railcars. From extensive experience with the maintenance of steel coaches it has been established that, whereas the relatively thick sections of the underframe are virtually corrosion free, body panels require periodic repairs or replacement on account of corrosion. As the cost of this averages about £35 per vehicle per annum that is the upper limit of the saving which a light alloy panelling could achieve, if it were corrosion free.

He concluded that light alloy gives very good service in railway carriage structures provided that adequate surface protection is given against corrosive atmospheres. Steel is better than light alloy for the buffers and other shock loaded components and where there is much abrasion. An aluminium alloy integral body structure may weigh 30 per cent less than a comparable design in steel, but cost £1100 more. There is a fuel saving, but "to break even" the useful operating mileage must be not less than 65,000 miles per vehicle per annum.

That the economies offered by lightweight constructions vary almost exactly with the mileage the vehicles cover was stressed in the paper by Mr. F. L. Stafford.

Writing about experience with aluminium in railway rolling stock in Canada, Mr. R. A. Campbell showed that 9361 tons (2000 lb) of aluminium have been used in Canadian rolling stock from 1953 to 1959. About two-thirds of the aluminium so used was built into box cars (2972), refrigerator cars (2038), and piggy-back trailers (1875), and passenger cars (1142) ; the remaining third being spread over ten other applications.

Monsieur Dupré reported in his paper many interesting uses of aluminium on the railways of France and in West Africa and Madagascar. More than a thousand cast aluminium wheel centres (Al—5 per cent Cu —Mg—Ti alloy) were incorporated in railcar trailers for West Africa and Madagascar. His illustrations included many special types of aluminium railway wagons for the transport of salt, alumina, sulphur, bananas, ground nuts, and so on. The Pechiney wagons made in 1950 for the carriage of alumina have covered 700,000 miles and are still as good as new.

Dr. Ing. A. Mielich gave similar details of the use of aluminium alloys by the German Federal Railways, where careful progress is being made in various fields of application aimed at weight reduction.

The discussions at this informative symposium may be well summed up by the following quotation from the final paper, which was by Gilbert B. Hauser, on experience in the U.S.A.: " After a comparatively slow start, aluminium is now gaining acceptance in the railroad field at an accelerating pace."

Oxidation of Steel by Carbon Dioxide

Recent developments in connection with nuclear reactors have shown that it is necessary to study the oxidation of mild steels by carbon dioxide. Consequently, the Corrosion Group of the Society of Chemical Industry arranged for a special meeting, at the end of its 1959-60 session, to provide an opportunity for the discussion of this and analogous problems. The meeting was open to all and well attended, the lecture room of the S.C.I. in Belgrave Square, London, S.W.1, being full for both the morning and afternoon sessions on June 15, 1960.

Under the chairmanship of J. A. Waddams, of the U.K. Atomic Energy Authority, some half-dozen papers were presented and discussed. Mr. C. S. Campbell introduced the subject on the basis of a paper written by himself with Dr. J. Boulton, of the U.K. Atomic Energy Authority, Culcheth, upon the subject of " Experimental Investigation of Oxidation by Carbon Dioxide."

The second paper was particularly helpful as copies were available which included novel photographs and photomicrographs illustrating the quite startling phenomena. It was presented jointly by Dr. M. Davies, of the General Electric Company, Ltd., and Mr. C. Moore, of A.E.I. (Manchester), Ltd., and reported work, carried out in various laboratories for the industrial consortia concerned in the manufacture of nuclear reactors, on the oxidation of ferritic steels in CO_2, CO_2–CO and CO_2–CO–H_2O gas mixtures.

This was followed by a paper by Dr. D. A. Melford, of Tube Investments Research Laboratories, Hinxton Hall, Cambridge, on the " Effects of Tramp Elements in Steel." Dr. M. D. Jepson then described studies of the " Breakaway Action in Oxidation " made by Dr. S. J. Gregg, University of Exeter, and discussed how the oxygen penetrates through an oxide film when the usual parabolic corrosion rate curve changes to linear.

The fifth paper was on " Electron Microscope Observations of Oxidation " by Mr. E. A. Brandes, of the Fulmer Research Institute. He showed a really fascinating set of lantern slides illustrating needle-like growths of Fe_3O_4 and Fe_2O_3 at the very high magnifications possible with the electron microscope. At 4μ or 1μ after oxidation for one minute at 700 deg. Cent., i.e. almost at once one may see a carpet of sharp needles sticking up from the surface. In some cases the form of this carpet pile of oxide appears like semi-discs, sometimes as tombstones or more substantial crystals ; sometimes the minute needles of oxide have on their points tufts of still finer growths.

The last two papers came nearer to the forms of corrosion with which we have become accustomed. Mr. G. M. W. Mann, of the Central Electricity Generating Board's Boiler Research Laboratory, described the " Oxidation of Steel in High Temperature Alkaline Waters " and said that mild steel was almost invariably used for boilers up to 360 deg. Cent. so they had tested it in a variety of alkaline boiler waters from 240 deg. to 370 deg. Cent. The results of their long series of tests were summarised in two graphs which showed the influence of variations in temperature, and variations in alkalinity, on the oxidation of the boiler tubes. Dr. G. Wood, University of Cambridge, also dealt with the " Oxidation of Low Alloy Steels in Steam " having in mind some thoughts on the oxidation of stainless steels and nimonic alloys as well as of mild steels and low alloy steels.

The requirements as regards continuity of uninterrupted useful service, without loss of essential physical and mechanical properties, are of course more stringent in the nuclear fields of engineering. The designers of nuclear energy plants must seek guarantees of resistance to loss by oxidation during continuous service for the next twenty years. To many of the engineers and metallurgists present at this meeting, about a hundred in all, this was the first public discussion of a new subject, but it soon became clear that a surprisingly large amount of experimental work has already been carried out quite recently in this field.

One hears and reads much of exotic materials which are essential for nuclear engineering, but they are in fact used in relatively small quantities, and by far the largest material requirements for nuclear reactors are mild steel and low alloy steels. Hence the use of structural steel components at moderately high temperatures, in nuclear power plants of the Calder Hall type, has focused attention on the kinetics of the reaction between ferrous materials and carbon dioxide. It must be remembered, however, that the coolant gas will probably contain water vapour, and will certainly contain carbon monoxide, as a result of the reaction of the carbon dioxide with the graphite. The influence of small additions of these gases has therefore also been investigated, in addition to the tests carried out with CO_2 only.

We are accustomed to find that steels oxidise during corrosion at rates which vary from being at first rapid to becoming slower as time progresses, according to a parabolic curve for weight increase with length of time. The rate of oxidation of red hot steel in CO_2 is sometimes very different to that and the barnacle-like growths, blisters or excrescences of iron oxides grow very rapidly from a smooth steel surface. If the surface be previously shot-blasted the oxide barnacles are smaller and cover the surface more uniformly.

So far the observations in Great Britain, France and U.S.A. have given little cause for alarm because the working temperatures are relatively low. The present temperature range of interest is 400 deg. to 500 deg. Cent., but the search for increased efficiency will tend to push up the working temperatures to those at which run-a-way pitting of the steel by oxidation may become a menace.

Theoretical Extraction

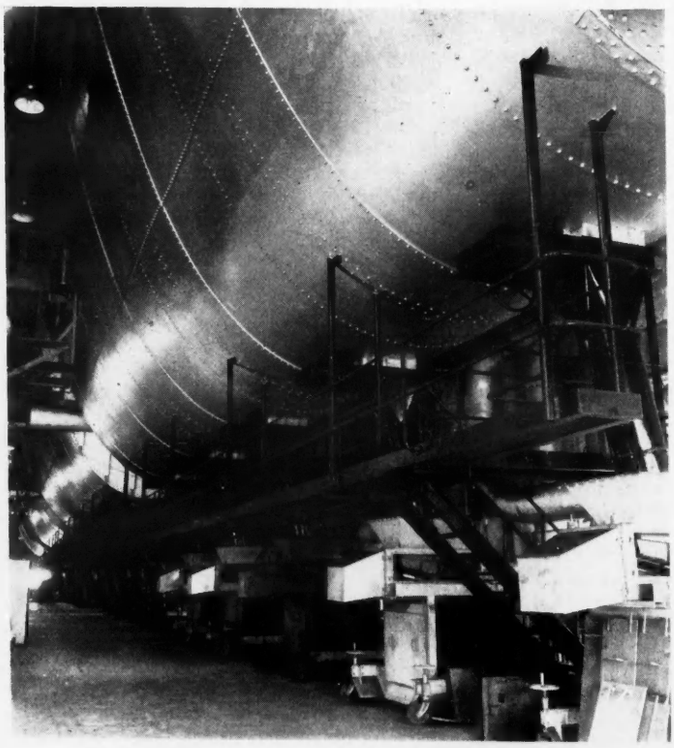
PRINCIPLES OF THE EXTRACTION OF METALS. (By D. J. G. IVES. The Royal Institute of Chemistry, London. Price 6s.) is the third of a new series of monographs published by the Royal Institute of Chemistry primarily for the many teachers of chemistry in schools. It was preceded by two similarly concise and authoritative accounts of the *Principles of Electrolysis* and the *Principles of Oxidation and Reduction*, which were written to help those who teach these subjects at G.C.E. Advanced Level and above. The small size of these monographs will make them also of value to engineers and metallurgists who seek a handy refresher course on these present-day first principles.

The author of this third monograph is Reader in Chemistry at Birkbeck College, London, and he has divided his subject under four headings : Thermodynamic Background, Thermodynamics of Pyrometallurgical Processes, The Choice of Extraction Methods, and finally Some Typical Processes. Had he been a metallurgist or engineer no doubt his monograph would have been very different for he does not deal with the engineering aspects.

In his 57 pages he has indicated ways in which the essential modern theoretical framework of school studies in chemistry may be made to catch the interest of youngsters. Their study will be altogether happier if they can thus be made to see that what they are learning matters greatly in the present-day production of essential materials.

Blyth "A" Power Station

Last week the fourth of the 120MW alternators of Blyth "A" power station was commissioned, and on Wednesday this week the station was formally opened by Mr. J. C. Mitchell, O.B.E., A.M.I.Mech.E., A.M.E.E., former Controller, North Eastern Division, Central Electricity Generating Board. The station is situated at Cambois, Northumberland, near the mouth of the River Blyth; it draws cooling water from the river and discharges it into the sea, so that recirculation is not a problem. The site is an "island" of restricted size of sandstone that has not been weakened by coal-mining, overlaid by a 70ft layer of strong boulder clay. The "island" will be virtually filled when the "B" station, now under construction, is completed; with two 250MW and two 375MW units, it will bring the Blyth installation up to 1730MW.



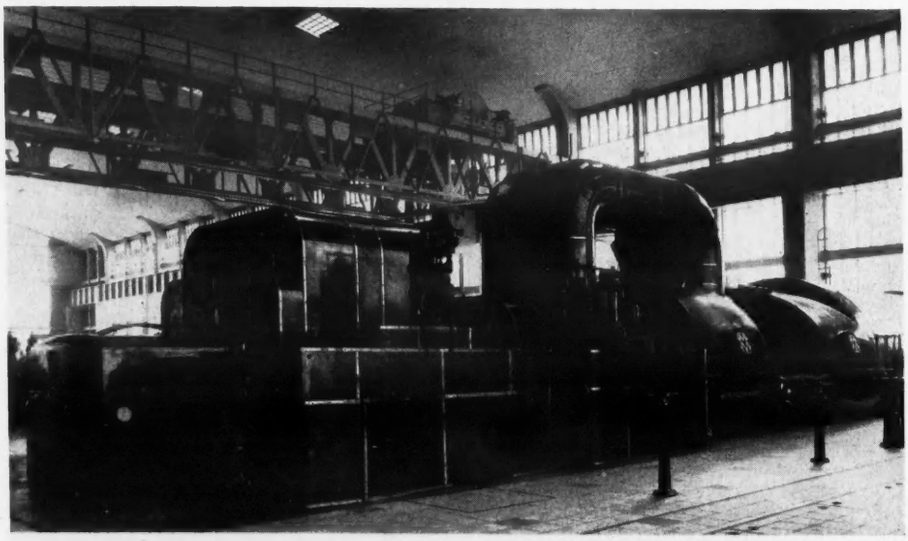
The station is intended to consume the local bituminous coal. The majority of the collieries are not able and willing to load into road vehicles, and hence coal arrives in 400-ton trains. British Railways can deliver only five days each week, so since this is a base-load power station very large stocks of fuel must be accumulated. Hence a much larger site on the far side of a public road is allotted to stock yards and sidings; this site is seen ABOVE. The bulk of the coal comes in bottom dump wagons, but a tippler is installed to handle side-emptying trucks. There are at present forty trucks, and a further sixteen will be required for the "B" station; the total length of sidings on the site will be 25 miles. The coal comes an average distance of 10 miles.

The steam-raising plant is a Babcock and Wilcox installation, distinguished by the use of a catenary construction for the bunkers, LEFT, above the pulverising mills. Because a three-dimensional catenary is not free to change its shape when it is loaded, and because the station may be supplied with sticky slurries, the internal shape is a straight-sided hopper defined by concrete walls; the bunkers of the "B" station revert to the conventional shape. The boilers are hung in the 150ft high steel-framed boiler-house, and hot air from the top of the house is drawn down to the burners through ducts formed by boxing in neighbouring columns. Each boiler delivers 860,000 lb per hour of steam at 1600 lb per square inch and 1010 deg. Fah. Ash is sluiced away, while dust from the mechanical and electrostatic precipitators is fluidised with compressed air and pumped to silos; moist ash and dust are loaded into a bottom dump self-powered barge and taken out to sea.

As mentioned above, the cooling water is saline, and the condensers must be protected from marine growth, such as mussels. A "Crustex" ultrasonic exciter installation is provided, but at present chlorination is being performed. A set of four pipes on the dockside are currently being fed with river water and given no protection, continuous chlorination, intermittent chlorination, and ultrasonic protection respectively, and the observation of these pipes after a long period will decide the form of protection finally to be used.

The four Metropolitan-Vickers turbo-alternators, each one in unit with its boiler, accept steam at 1500 lb per square inch and 1000 deg. Fah, with reheat to the same temperature at 422 lb per square inch. The double-flow low-pressure cylinder has Baumann exhaust stages. The 13·8kV generators are hydrogen cooled. The outputs of the first three machines are transformed to 66kV, but the fourth has a transformer feeding directly into the 275kV super-grid. Each machine also has a step-down transformer supplying 3·3kV for the station auxiliaries. 275kV, 66kV, and 3·3kV systems are all controlled from a room in the central administrative block, which was originally intended to control the "B" station as well.

The turbine hall, RIGHT, is a reinforced concrete structure, and supports a 160-ton overhead crane. An interesting detail is that, to avoid the crane being halted for trivial maintenance tasks, the electric lights in the roof are serviced from outside the building.



Diesel-Electric Pullman Trains

On Monday the first of the British Railways diesel-electric Pullman services will be introduced on the London Midland Region between Manchester (Central) and London (St. Pancras), and between St. Pancras and Leicester. At an early date Pullman services with similar rolling stock will operate on the Paddington–Wolverhampton and Paddington–Bristol routes of the Western Region. The rolling stock designed and built for these services is described below.

FIVE trains have been built by the Metropolitan-Cammell Carriage and Wagon Company, Ltd., to the requirements of the British Transport Commission, for the new diesel-electric Pullman services on the London Midland and Western Regions of British Railways. The principal sub-contractor for the traction equipment was The General Electric Company, Ltd. Two of the trains are six-car, first class only, sets for the Manchester–Leicester–London route, and the other three are eight-car formations (Fig. 1) with first and second class accommodation for Bristol–London and Wolverhampton–Birmingham–London services. The trains have a 1000 h.p. power car, also containing a guard's compartment and passenger saloon, at each end, and include two kitchen/parlour cars for the service of meals to passengers at their seats. The other vehicles are centre-gangway parlour cars (Fig. 2). All the stock is air-conditioned. A six-car train in working order weighs 299 tons, and an eight-car train 364 tons.

The car bodies are of integral tubular construction, largely of low-alloy corrosion-resistant steel and with extensive use of spot welding. Roofs, sides and floor are heavily insulated against heat and sound, and the floor actually "floats" on the underframe on rubber blocks. There are two forms of suspension on the bogies. In the motor bogies the bolster centre pivot takes the whole of the body weight and transmits the traction and braking forces. Side bearing surfaces are provided on the bogie frame and underframe but these are not normally in contact and serve only to prevent body roll. In the trailer bogies, on the other hand, the centre pivot acts only as a guide, the body weight being taken on spherical bearings at the ends of the bolsters, enclosed in oil baths. Traction and braking forces are transmitted by horizontal rod links between the bolster and the bogie frame.

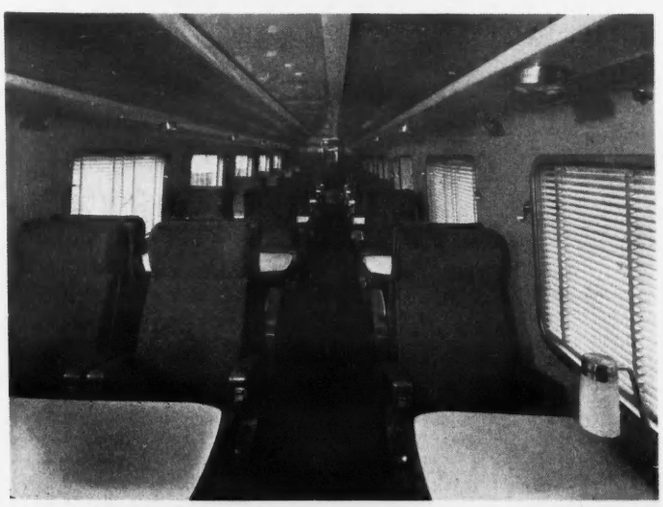
Fig. 1—Eight-car set of first and second class Pullmans. External finish is Nanking blue.

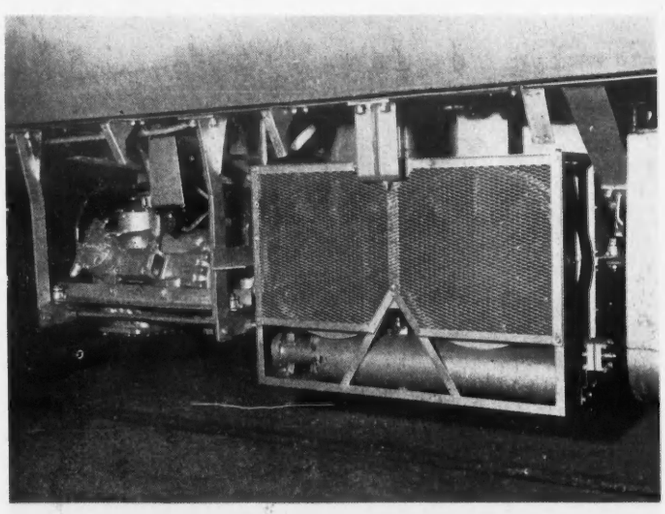
Both forms of bogie are of the Metro-Schlieren all-welded pattern specially developed by Metropolitan-Cammell for these trains. Primary and secondary suspension is by coil springs, the bolster being carried on the spring plank by pairs of springs at each end, while the primary springs carrying the axle-boxes from the bogie frame incorporate the Schlieren telescopic guiding and damping assembly within the spring housing to control axle movements. Inclined swing links carrying the spring plank from the bogie frame allow the bolster a sideways movement of 1in in each direction, after which it is checked by rubber buffers. Bolster movements are also damped by shock-absorbers. The passenger access gangways between vehicles are mounted on pivots at the end of each coach so as to form semi-floating units between pairs of cars and provide a level platform free from oscillation.

Air Conditioning and Auxiliaries

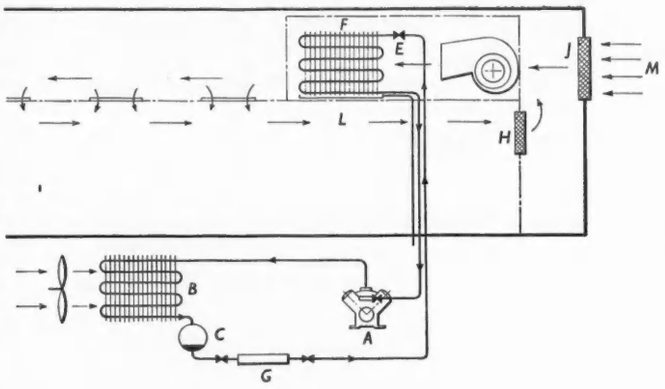
Stone-Carrier air-conditioning equipment, supplied by J. Stone and Co. (Deptford), Ltd., provides for circulation in the vehicles of air which is controlled for temperature and humidity within established comfort limits regardless of outside conditions. The airflow and refrigeration systems of the conditioning system in each vehicle are shown schematically in Fig. 4. Outside air *M* is introduced through filter *J* and mixed with a proportion of return air *L* which has been filtered through filter *H*. This mixture is then blown over the cooling coils of evaporator *F* by centrifugal fans, delivered to the air duct and distributed to all parts of the car. Part of the air escapes to atmosphere through static ventilators, but a slight pressure is always maintained inside the car. The fan and evaporator form the air-conditioning unit, mounted above the car ceiling. Moisture in the air is condensed in passing over the cooling coils of the evaporator, which are at a temperature below the dew point of the air. When heating is required the cooling coils are inoperative, but a group of heating elements in the unit is energised. Floor heating units are also fitted in the cars.

The refrigeration system associated with the evaporator is carried on the vehicle underframe (Fig. 3) and consists of the





Figs. 2 and 3—(Left) Interior of first class car. Conditioned air is admitted through apertures concealed by the longitudinal mouldings at each side of the fluorescent lighting panel in the ceiling. (Right) Arrangement of compressor and condenser on vehicle underframe



A—Compressor.
B—Condenser.
C—Liquid receiver.
E—Expansion valve.
F—Evaporator.
G—Dehydrator and filter.
H—Return air filter.
J—Outside air filter.
L—Return air.
M—Outside air.

Fig. 4—Air circulation and conditioning system

compressor, condenser, liquid receiver and dehydrator/filter unit shown in Fig. 4. Operation of the system is fully automatic under the control of " Vapor " thermostats, which operate pilot relays. With the circulating fan in operation, a demand for heating causes the heating contactors to be energised. When the demand is for cooling, the motor line contactors are energised to start the condenser fan motor and the compressor motor through a star-delta sequence.

Auxiliary power and lighting equipment were also supplied by Stone's. Electrical supplies for the air-conditioning plant, as well as for train lighting, are provided by a " Tonum " 133kVA three-phase alternator driven by a Rolls-Royce " C8NFLH " engine on the underframe of the vehicle next to the power car at each end of the train. This is an eight-cylinder horizontal engine delivering 190 b.h.p. at 1500 r.p.m. and having many parts interchangeable with similar Rolls-Royce units used for traction in British Railways diesel trains.

The electrical supply is at 400V, 50 c/s and is distributed through the train by two four-wire feeders. Normally one power unit acts as a standby, but both are required for extreme winter conditions. The fluorescent lighting which provides most of the illumination in the trains is fed at 230V by connection between phase and neutral. Filament lighting is supplied at 110V through a 230V/110V lighting transformer. A three-phase transformer-rectifier unit on every car provides 24V d.c. for the air-conditioning fan motor and control circuits, and also charges a 24V, 216Ah battery, for the emergency lighting supply which is mounted under the car with the transformer rectifier unit.

Traction Equipment

In each power car of a train the main and auxiliary generator group is driven by a N.B.L./M.A.N. 1000 h.p., twelve-cylinder, vee engine supplied by the North British Locomotive Company, Ltd., together with the cooling groups and engine accessories, as sub-contractor to the G.E.C. This engine-generator combination is similar to that in the N.B.L./G.E.C. type 2 locomotives for British Railways described in our May 15, 1959, issue. From each power car current is fed to four traction motors, two in the rear bogie of the power car itself and two in the leading bogie of the adjacent vehicle. Immediately behind the driving cab is the Serck radiator unit with Serck-Behr hydrostatic fan drive, and beyond this is the engine-generator set, a bulkhead separating the engine from the generators. Fig. 5 is a view in the generator compartment showing the main control switchgear cabinet and auxiliary cabinet, with the roof-mounted resistors of the main generator field control system. Main generator continuous ratings at 1500 r.p.m. are 1700A, 383V, 650kW or, 1250A, 523V, 650kW. The auxiliary generator, carried on an extension to the main generator shaft, is rated continuously at 91A, 110V, 650/1500 r.p.m., 10kW.

A thirty-six-line control cable runs through the train for simultaneous control of the two power plants. There are ten control notches, the first three building up the generator excitation while the engine runs at its idling speed of 340 r.p.m., and the remainder increasing the engine speed in steps to its maximum. Automatic control of generator excitation by a servo-operated field regulator is effective from steps three to ten.

Field-weakening of the traction motors takes place in the appropriate conditions under the control of a transition relay in the generator field circuit. A single weak-field step is provided by diverter resistances, which are mounted on top of the main switchgear cabinet as seen in Fig. 5. The housing contains the diverters for the four motors, the value of those for the two motors in the bogie of the adjacent coach being adjusted to allow for the voltage drop in the inter-coach cable connections.

A current-limit relay arrests the increase of generator excitation by the automatic load regulator during acceleration of the train if the current exceeds a predetermined setting. When the current falls, with increasing train speed, to the relay drop-out value, the increase of excitation is resumed under the normal control of the load regulator. On the final power notch an eight-car train will balance on level track at its maximum service speed of 90 m.p.h., and up a gradient of 1 in 100 at 54 m.p.h.

These trains are the first diesel units on British Railways to have fully springborne traction motors. Fig. 6 shows the flanges by means of which a motor is bolted to the vertical face of a bogie transom. An additional top suspension point from the bogie frame is also provided. Torque is transmitted through a Brown-Boveri spring drive

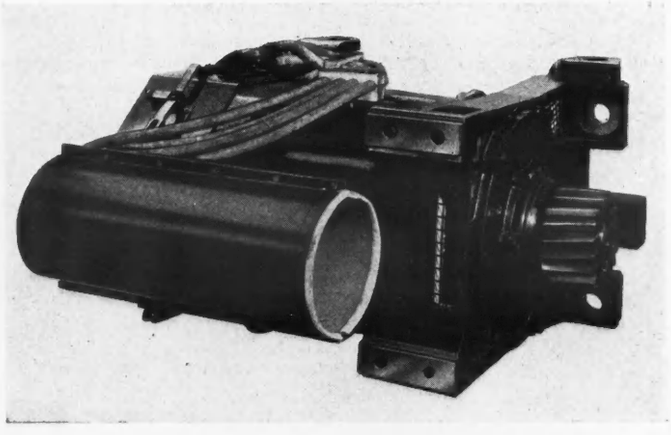


Fig. 5—(Left) Control equipment in power car, showing motor weak-field resistors on top of main cubicle and resistors of automatic generator field control system in roof

Fig. 6—(Above) Traction motor, showing flanges by which the machine is bolted to a bogie transom and points of attachment for spring drive to axle

clamped to the motor frame at the driving side. The two motors in a bogie, connected in parallel, are four-pole self-ventilated machines with a rating of 425A, 383V, 199 h.p. at 1360 r.p.m. Gear ratio is 19/67.

Two-Stage Braking

The trains are fitted with the latest form of Westinghouse two-stage electro-pneumatic brake, and with the standard Westinghouse automatic air brake as a standby service brake. The two-stage air brake overcomes the limitation of cast iron brake blocks that a high braking force for deceleration from speed may cause skidding of the wheels at low speeds. In the two-stage system the brake force is increased automatically at high speeds, when high forces may be used with safety and advantage, and is reduced automatically as speed falls to a level known to be safe for low-speed running. An indicator lamp shows the driver when the high-speed brake is cut-in and the higher brake force is therefore available when the brake is applied. This is the first application of the two-stage brake

Demonstration Journey

A demonstration journey in an eight-car train from Marylebone to High Wycombe and back on June 23 gave the opportunity to appreciate the harmonious décor of the vehicle interiors and the variations in this respect between different vehicles which add interest to the scheme. Aesthetic design was specially studied by Metropolitan-Cammell in consultation with Mr. Jack Howe, F.R.I.B.A., F.S.I.A., who has been design consultant for the project and was appointed with the approval of the British Transport Commission's design panel and of the Pullman Car Company. Reclining seats in first-class saloons and, between the double-glass of the windows, venetian sunblinds, lowered and raised by winding handles conveniently placed, are typical of the many attentions to passengers' comfort. Outstanding impressions of the journey were the effectiveness of the sound insulation and the rapidity and smoothness with which the train accelerated and decelerated. The efficiency of the air-conditioning is best judged by the fact that the passenger only became fully aware of how comfortable conditions had been in the train when he emerged into the sultry heat, which was oppressing London after violent storms earlier in the day.

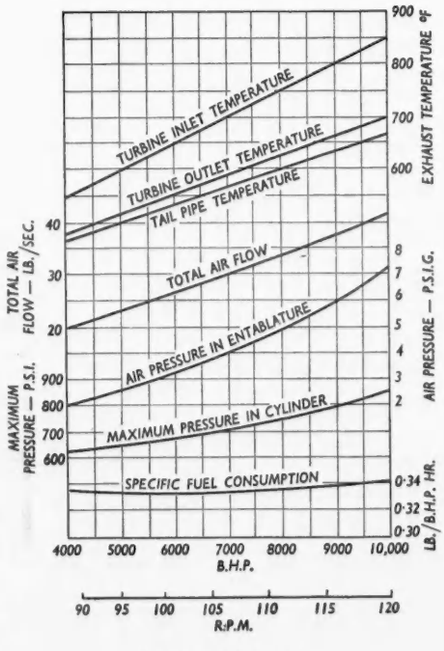
A commentary on the speeds attained was broadcast over the train public address system, which, with the "Loudaphone" communication between driver and guard, has been supplied by Clifford and Snell, Ltd. There are various speed restrictions between Marylebone and High Wycombe, but after slowing over Neasden Junction the train reached 70 m.p.h. after 4 miles of mainly rising track before the further slack at Northolt Junction. On the 1 in 175 up grade after Denham 70 m.p.h. was announced, and the falling track from Beaconsfield brought 85 m.p.h. on the 1 in 225 to White House Farm tunnel, followed by 90 m.p.h. maintained on the level approaching High Wycombe before stopping in the station. Here the train was crossed over on to the up line for the return journey and again reached its permitted maximum of 90 m.p.h. while running down 1 in 254 to Gerrards Cross before slowing for Ruislip troughs and the junctions beyond. We were informed that the maximum power notch had only been used briefly for acceleration and that the running had been mainly in notches six and seven, representing combined inputs to the two main generators of 1014 h.p. and 1238 h.p. respectively.

Doxford "P" Range of Engines

Advances in design and modifications in detail have resulted in the production, by William Doxford and Sons (Engineers), Ltd., of its new "P" range of engines which have greatly reduced overall dimensions and weight.

LAST year, when describing the Doxford 70 L.B.D. "S."6 engine, which is a turbocharged unit having a maximum rating of 10,450 b.h.p. at 120 r.p.m. with a M.I.P. of 116 lb per square inch gauge equipped with two turbochargers, we indicated that forward thinking by the company was concerned with the reduction of weight and length. The results of such thinking were illustrated in our August 21 issue by drawings of the elevations of the current and future engines, and these clearly showed the considerable reductions in dimensions and weight of the projected "P" range. A prototype single-cylinder unit has completed over 5000 hours of running to test and develop new concepts of design and, based on the experience gained and the test bed data collected, a six-cylinder engine having a bore of 670mm and opposed pistons of 720mm stroke and 1380mm stroke for the upper and lower pistons respectively has been built. The engine has a service power rating of 10,000 b.h.p. at 120 r.p.m. and has a length of 45ft 6in, a height of 31ft 2in, a width of 12ft 2in and a weight of 375 tons, which is equivalent to 26·7 b.h.p. per ton, or 84 lb per brake horsepower.

In designing the new "P" engine there has been a careful examination and assessment of the various criteria governing the operation and life of the unit and every endeavour has been made to satisfy these criteria in the following order of importance: reliability, cost, fuel consumption, cheap and easy maintenance, length and weight. This order was considered by the designers to give the best compromise in satisfaction of overall requirements. The main factor contributing to the reduction in the length, and consequently the weight, has been the adoption of a shorter and stiffer crankshaft associated with larger diameter plain bearings of short length, spherical bearings being eliminated.



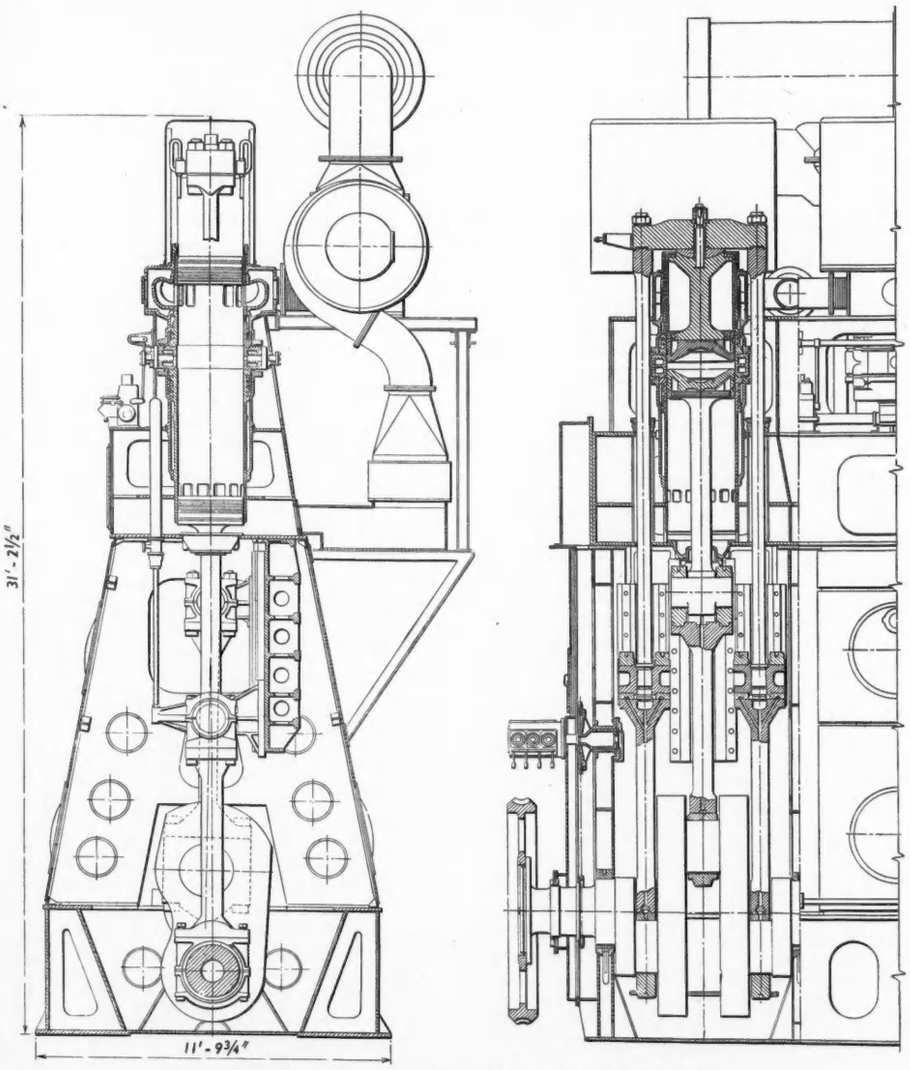
Test bed performance

Furthermore, the transverse beams carrying the load from the upper pistons to the side rods have been simplified, while the firing load is transmitted directly from the crosshead to the connecting-rod by means of the new design of centre top-end incorporating a lead-bronze pad. The engine has been running on the test bed for several months during which time several turbo-charger arrangements have been tried, together with various fuel valve nozzles and varied swirl, in an endeavour to attain the best possible performance. Test bed performance figures are set out in the accompanying graph and show that the high rate of airflow from the turbo-chargers has resulted in a moderate full load exhaust temperature. Also indicated is that the fuel consumption is low and varies little over powers ranging from 4000 to 10,000 b.h.p. It is reported that, during the test bed running, no mechanical faults have developed and that the engine starts easily and will run over the range of speed from 20 to 124 r.p.m. using the exhaust turbo-chargers only. The Mark 67PT6 engine shown in the test bed has three Brown-Boveri exhaust gas turbo-chargers.

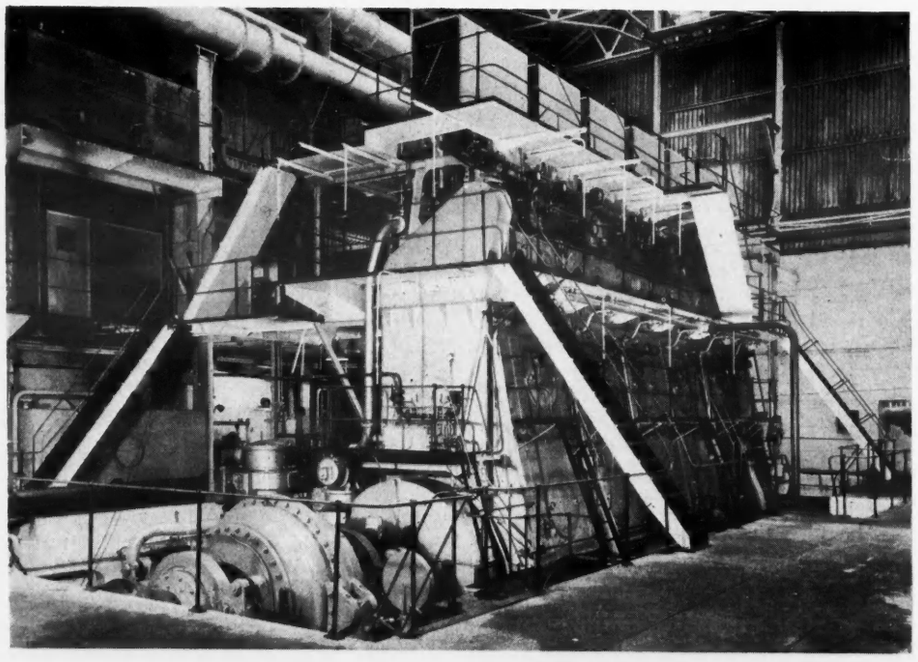
Our line drawing gives a section and part elevation of the engine. The stress relieved welded bedplate is deeper than earlier designs and of greater rigidity and consists of two longitudinal box girders joined by double transverse girders incorporating the main bearing housings which are bored parallel.

Both piston-heads are machined from steel forgings, are interchangeable, and have cast iron rings. The upper piston-rods are bolted direct to the piston-heads and fastened by centre bolts to solid steel forged transverse beams, having a spherical pad to take the load and provide self alignment for the piston. Side rods are rigidly attached to the beams and screwed into the side crossheads, which have cylindrical bearing surfaces at the ends. The lower piston-rod has a circular top flange, which is inserted into the piston-head, and a palm ended lower end bolted directly to forged and flame-hardened centre crosshead. Both centre and side connecting-rods are palm ended: the ratio of the length of the centre rod to the centre crank throw is 3·85, the ratio of the side rod length to side crank throw being 7·85. Top and bottom end bearings of the side connecting-rods are white metal lined as are those for centre connecting-rods; there is in addition a leaded bronze pad arranged directly under the piston-rod to take part of the load directly on to the rod.

The two-piece crankshaft is joined by a large diameter rigid coupling and the ratio of side crank to centre crank throw has been reduced to give reciprocating balance which, in conjunction with the large diameter journals, provides greater rigidity and raised natural frequencies of both torsional and axial vibrations, so that engines of fewer than six cylinders will not require a detuner. The shaft is carried in pressure-lubricated steel shell, white-metal-lined thin wall bearings, the keeps being steel straps having thin white metal linings. Pressure fed lubrication of the side crank pins is via the main bearings, while the feed for the centre crank pin is down the connecting-rod from the crosshead bearing.



Vertical sections and part elevation of Doxford "67 P.T.6" engine.



Mark "67 P.T.6" engine on test bed

The main particulars of the turbo-charged engines, Mark 67PT, are given in Table I, and in Table II are listed the particulars of the normally aspirated engines, Mark 67PN, which are fitted with a double scavenge air pump for each cylinder driven by arms from the side crossheads and incorporated in the crosshead guides.

TABLE I

Mark	Continuous service rating		Length	Engine weight (tons)
	B.h.p.	R.p.m.		
67PT4	5,800	105	34ft 10in	245
	6,080	110		
	6,640	120		
67PT5	7,250	105	41ft 3in	320
	7,600	110		
	8,300	120		
67PT6	8,700	105	45ft 6in	375
	9,120	110		
	10,000	120		

Bore, 670mm ; Stroke, combined 2100mm, upper 720mm, lower 1380mm. M.I.P., 135 lb per square inch ; B.M.E.P., 121 lb per square inch ; Breadth, 12ft 2in ; Height, 31ft 2in.

TABLE II

Mark	Continuous service rating		Length	Engine weight (tons)
	B.h.p.	R.p.m.		
67PN3	3,210	105	28ft 7in	180
	3,360	110		
	3,675	120		
67PN4	4,280	105	34ft 10in	225
	4,480	110		
	4,900	120		
67PN5	5,350	105	41ft 3in	290
	5,600	110		
	6,125	120		
67PN6	6,420	105	45ft 6in	340
	6,720	110		
	7,350	120		

Bore, 670mm ; Stroke, combined 2100mm, upper 720mm lower 1380mm. M.I.P., 100 lb per square inch ; B.M.E.P. 89 lb per square inch ; Breadth, 11ft 10in ; Height, 31ft 2in

TABLE III

Mark	Continuous service rating		Length	Engine weight (tons)
	B.h.p.	R.p.m.		
85PT4	10,400	100	40ft 0in	440
	11,400	110		
	12,000	115		
85PT5	13,000	100	46ft 6in	510
	14,300	110		
	15,000	115		
85PT6	15,600	100	55ft 6in	590
	17,200	110		
	18,000	115		

Bore, 850mm ; Stroke, combined 2500mm, upper 830mm, lower 1670mm. M.I.P., 132 lb per square inch ; B.M.E.P. 119 lb per square inch ; Breadth, 14ft 6in ; Height, 37ft.

TABLE IV

Mark	Continuous service rating				Length	Engine weight (tons)
	B.h.p.	R.p.m	M.I.P. lb/sq in	B.M.E.P. lb/sq. in		
56PT4	4,120	120	144	130	29ft 9in	160
	4,300	130	140	126		
	4,480	140	136	122		
	4,640	150	132	118		
56PT5	5,150	120	144	130	35ft 9in	195
	5,375	130	140	126		
	5,600	140	136	122		
	5,825	150	132	118		
56PT6	6,180	120	144	130	41ft 0in	227
	6,450	130	140	126		
	6,720	140	136	122		
	6,990	150	132	118		

Bore, 560mm ; Stroke, combined 1750mm, upper 630mm, lower 1120mm. Breadth, 10ft 6in ; Height, 26ft.

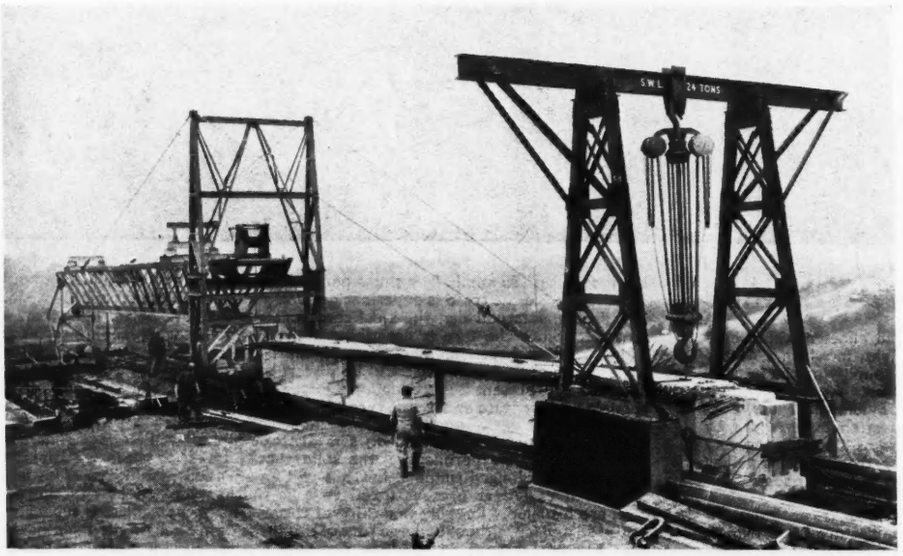
Based on a re-appraisal of the direct-coupled, opposed-piston, in-line oil engine and the results obtained with the new "P" range, the company has decided to go forward with two further ranges of the turbo-charged engines. One engine will be

of larger bore and the other of smaller bore and both will be modelled in the 67PT engine and so will not be prototypes. The larger engines will have a bore of 850mm by 2500mm combined stroke with the six-cylinder unit developing a maximum of 19,800 b.h.p., or 18,000 continuous brake horsepower at 115 r.p.m. According to the weight given in Table III, which records the main characteristics of an engine which has both pistons water-cooled, the engine develops 30·5 b.h.p. per ton or has a weight per horsepower of 73·4 lb. Work is to commence shortly on the construction of a 85PT6 engine, and it is expected to be completed by the end of 1961.

Table IV gives the main particulars of the smaller size of engine, which has a bore of 560mm and a combined stroke of 1750mm. This unit has been introduced to enable the Doxford engine to enter a market not previously catered for, and it will be noted that the power range overlaps the range of the 67PN engine. It must not be assumed, however, that this duplication indicates in any way that the engine will supplant the normally aspirated unit, for which there remains a considerable demand.

Bridge Launcher of Light-Alloy

CONSTRUCTION of the Southern and Western by-pass road at Oxford includes a Wolvercote viaduct, which carries the new road over the main railway line, the Oxford Canal and the A.40 trunk road. The viaduct, when completed, will be 819ft in length, and will consist of twelve spans from 40ft to 73ft in length, built of simply-supported precast prestressed concrete beams. The deck will be divided into two, each half consisting of a 24ft carriageway and a 6ft footpath, carried by six beams. This structure will be completed by cast *in situ* diaphragms and deck, and will be transversely prestressed.



On the embankment the concrete forms a counterweight as the whole assembly is winched along rails. The structure in the foreground is for lifting the beam on to the rails after its arrival at the site

Truss spanning the main A40 Oxford road, over which the viaduct is being built

The spans will rest on either cast *in situ* circular columns or cast *in situ* transoms carried on precast legs. Pinned joints at top and bottom of the columns (of either kind) will allow articulation of the structure in a manner such that thermal movement can be taken up at one expansion joint. This joint will be a somewhat elaborate tongued and grooved device with machined steel sliding surfaces, capable of taking up a considerable range of movement.

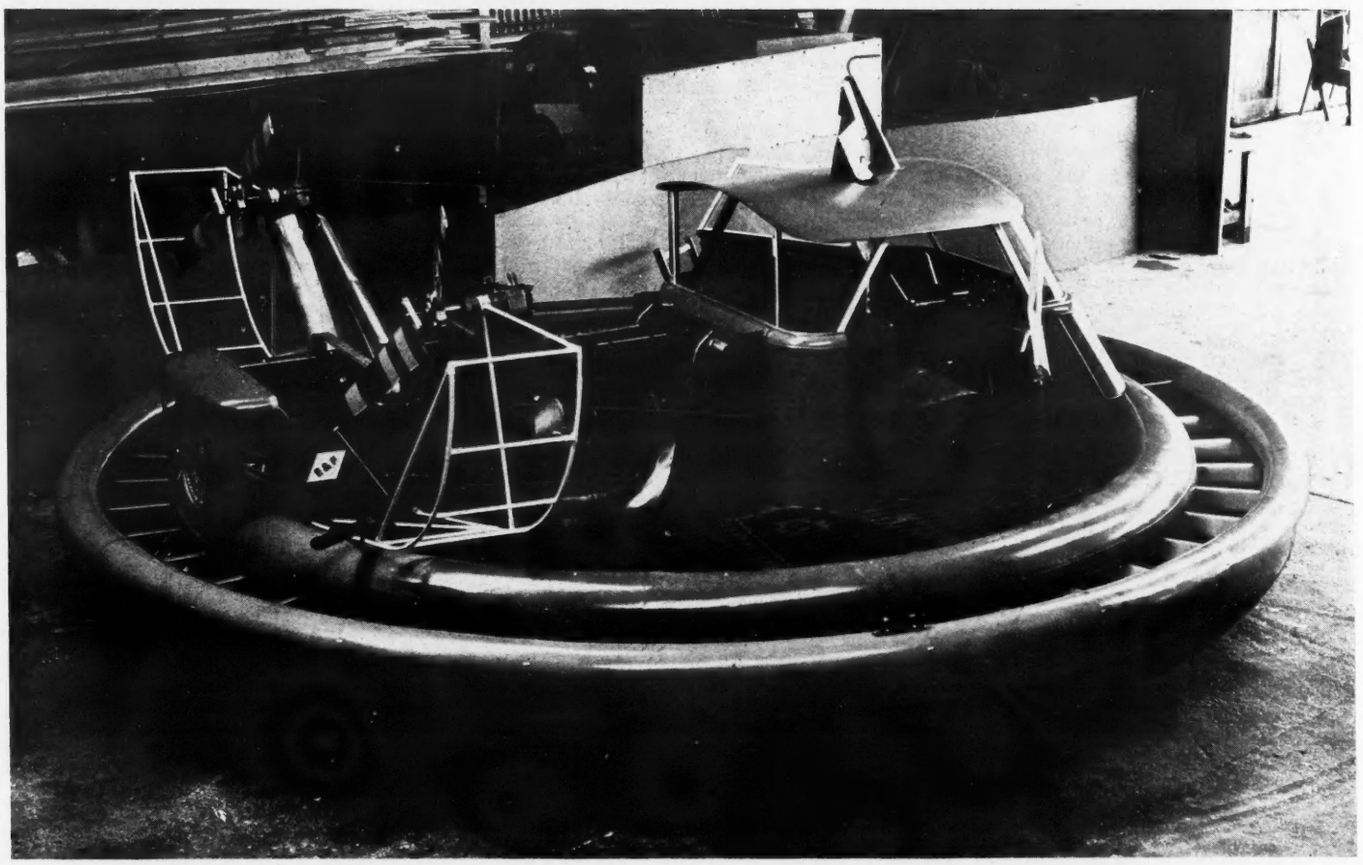
The most novel aspect of the viaduct, however, lies in the use of a "launcher," a temporary beam which is used to roll out the primary beams of each span progressively, from the completed work. This method of construction is of rather general interest in view of its possible future application on elevated urban motor roads. Last week, the "launcher" was itself launched across the span above the A.40, and was brought into use to place the first beams (in fact two spans had been constructed using a crane).

The launcher, which is of light alloy, is illustrated in the accompanying illustrations. As can be seen it is a trussed girder of triangular cross section, with a heavy bottom boom. This latter is shaped like a "Y" with a heavy flange added across the base of the "Y." On this flange run the wheels of the two cradles which carry the beams. The two assemblies above the girder proper carry jacks and after a beam has been rolled out, it is held by stirrups from the crossheads serving these jacks, and then lowered on to its bearings.

In addition to the girder itself, the launcher has two tower-structures, a leading one extending below the girder and having wheels which bear on a cross rail which is mounted on the column heads. At the "following" end, a more substantial tower, carried on a transverse rail track, rises above the girder. A longitudinal rail track, positioned on the work already completed, is used to move the launcher out over a run span. When this is to be done, ties are taken from the leading edge of the launcher up over the "follower" tower, and down to an anchorage at the end of a bridge beam, which is used as a counterweight for this operation, and is itself carried on the longitudinal rail track. The two towers can both be slewed in relation to the centre line of the girder, and when the launcher has been "landed" and the counterweight beam disconnected, it is a fairly simple matter to transfer the "follower" tower to its bogie on the transverse track.

The heaviest beam to be placed by the launcher weighs 38 tons. The girder of the launcher is 90ft 6in long and weighs 4½ tons, and the "leading" or outboard mast weighs ½ ton. The "following" or inboard mast, is of mild steel, is 30ft high, and weighs 4 tons. There is a winch—at present hand-operated—on the inboard mast. There are four 15-ton jacks to lower the beams. It is thought that the launcher will allow a rate of progress of one beam per day. Later, a second launcher is to be installed at the opposite end of the viaduct.

The by-pass is being built for the Ministry of Transport to the design and supervision of Mr. K. P. Brow, the county surveyor of Berkshire. The consulting engineers for the bridges, including, of course, Wolvercote viaduct, are Messrs. R. Travers Morgan and Partners. The main contractor is Higgs and Hill, Ltd. The light alloy launcher was made by Head Wrightson Stockton Forge, Ltd., and the main beams are being made by the Concrete Development Company, Ltd.



Annular Jet Ground Effect Machine

Details were disclosed last week of an unusual ground effect machine built by Britten-Norman, Ltd., Bembridge Airport, Isle of Wight, in which a ducted fan is adapted to the annular jet configuration, thereby simplifying the internal aerodynamics at the cost of much mechanical complication. At the time that ground effect machines came to be regarded as practical, Elders and Fyffes, Ltd., realised that they promised to avoid the severe degradation experienced by bananas when carried from the plantations by road, as well as obviating the very expensive task of building roads capable of withstanding tropical rains ; they would also be able to navigate the rivers in dry as well as wet seasons.

The only commercially available ground effect machine is not able to alight on water in case of engine failure, and so the manufacture of an experimental machine that could be sold cheaply to those interested in trying out the principle was undertaken. To keep cost down, it was determined that an automobile engine be used, and this meant that power losses had to be held to a minimum. The designer, therefore, adopted an inwardly-inclined annular jet for support and mounted an enormous ducted fan above it, thus both avoiding diffuser losses and claiming the improved efficiency of a high hub-to-tip radius ratio fan, while the jet velocity is held to the low value of 60ft per second. The vehicle is hence essentially circular, being 18ft 10in in diameter, and it has an empty weight of 1 ton.

The engine is a 2-litre Coventry Climax " FPF " of 170 b.h.p. The fan has a design blade speed of 290ft per second. The fan is driven at less than 300 r.p.m. but more than 195 m.p.h. by a single perfectly standard car tyre, a Michelin " X " 165×15 ; since the tread is experiencing 2750 g at the peak speed of 2650 r.p.m., it will be understood that the steel cord construction with only a light tread is an asset. Since the tyre is describing a circular path corresponding to 300 g, while the normal reaction increases with speed due to the fixed standing height, some traces of uneven wear could be discerned. It is hoped that, to avoid the need for the present 2 : 1 reduction between power unit and tyre, it will be possible to substitute an aircraft tyre of smaller diameter.

The fan proper is supported on sets of three aircraft tail bumper rollers at intervals round the perimeter ; the solid rubber tyres on these are liable to overheat in prolonged running, but this will be obviated when tyres of " Duthane," such as are at present fitted to take the heavy reactions opposite the tyre, are installed. Roughly one-third of the weight of the vehicle is supported by the ducted fan, although a large part of this lift is developed on the fixed intake lips. The straightener blades below the fan are provided with small slats, largely because the theoretical stagger proved too slight.

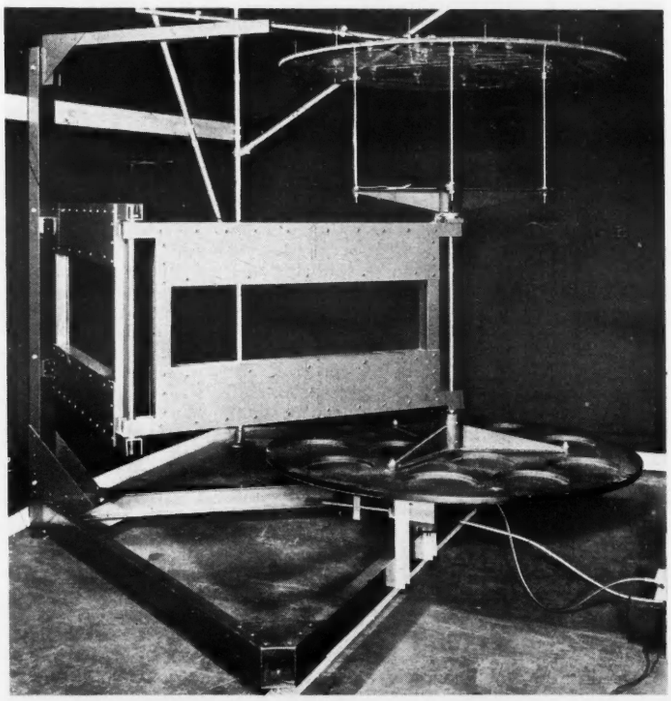
The " Cushioncraft " is controlled by an identical pair of helicopter tail rotors controlled differentially by turning and collectively by pushing and pulling the pilot's control wheel ; speed control is highly sensitive, since the rotors not only push but also tilt the craft in the desired direction. There is no lateral control, the inherent stability of the curved jet sheet being relied upon to overcome any thrust difference between advancing and retreating sides. The ducted fan is characteristically subject to changes of pitching moment with velocity in the plane of rotation, and hence up to last week the machine had not been flown outside its hangar.

Universal Automobile Simulator

THE simulator is now well established as a training aid for applications when training at full scale is too expensive or dangerous—well-known examples are warships, aeroplanes, and nuclear reactors. A simulator has now been developed by General Precision Systems, Ltd., Aylesbury, Bucks, which is new in concept in that it incorporates the machine on which it is desired to instruct and simulates the response of the environment ; the gain in realism is fully exploited, since any individual machine can be mounted on the simulator.

The new simulator is intended to give learner drivers their first acquaintance with a motor car ; it can be predicted that with the simulator it will be possible to ensure that pupils know the functioning of clutch, brake, throttle, gear shift, and steering before entrusting them with a car on a road. It is also possible to use the simulator to develop drills and skills—for instance, releasing the hand-brake before starting, and changing gear without disturbing the course of the car. If the car is driven so as to touch the verge of the " road," an alarm sounds. A device measuring the time taken to apply the brake after a signal is illuminated can be incorporated. The simulator can be adapted to whichever car it is desired to teach, the only major alteration being to select a pedal position pick-off for the particular car.

The G.P.S. simulator is unusual in being basically a mechanical rather than an electrical analogue. The presentation of the environment is in the form of a projection of a transparent model on to a screen in front of the driver, the projection being from the opposite side of the screen. The light source is positioned opposite the driver's eyes, and the model landscape, made of transparent plastic, is moved below it by a drive unit. The velocity of the model is determined by the driver of the car ; the direction of movement is established very simply by linking the turntables carrying the front wheels by mechanical remote control to the drive unit. The speed of movement depends on the throttle pedal position and on the gear ratio selected by the instructor on his panel, the various ratios being established by friction drive to different sized drums. The drive unit is powered by an electric motor, the speed of which increases as the throttle is pressed and decreases as the brake pedal is pressed. Depression of the clutch lights a lamp on the instructor's panel, reminding him to change " gear " and allowing him to check that the pupil is disengaging the clutch at the appropriate moments. The pedal position pick-offs form a sub-assembly which is individual to a particular car model, and the different assemblies are readily interchangeable, being linked to the instructor's panel and the simulator proper by electric and, for the brake, Bowden cable.



The visual projection system: the transparent model is moved under the light source by a drive unit in contact with the bottom disc. The mechanical remote control visible in the foreground turns the drive unit in synchronism with the front wheels of the car

The appearance of the presentation as seen from behind the pupil

A "Victor" mounted on the simulator: the turntables supporting the front wheels can be seen. On the far side of the bonnet is a stop-clock displaying brake reaction time

The basic simulator, which is supplied with pedal assemblies for six popular cars, costs less than any four-wheeled car in England ; it normally runs off the mains supply, but a low-cost version will run off the battery of a 12V car.

A " Sim-L-Car " was demonstrated last week in London. As explained above it is intended to be used only *ab initio*, and so the simulation is not sufficiently refined to deceive the experienced driver. The finite size of the light source in the projector gives a faintly fuzzy image, and the image of the filament in the far side of the spherical envelope projects a second, fainter, image above the first ; at certain attitudes, the columns supporting the model appear as black shadows on the screen. Since the drive unit is turned by the front wheels of the car, the response of the simulator is that of a car with an infinitely short wheelbase, and hence extremely quick. Obviously, real tyre effects are not reproduced, but these imperfections are immaterial for the speeds used by pupils making their first acquaintance with a car.

SHORTER REPORTS

Sixth International Congress on Bridge and Structural Engineering

THE International Association for Bridge and Structural Engineering has been holding its sixth international congress during the course of this week in Stockholm.

An abstract from one of the general reports before the congress is reproduced on page 4 herewith. This general report covers group VI of the congress's "preliminary publication." The subjects dealt with in this publication, apart from group VI, are as follows: first of all "general questions," namely group I, basis of structural design, general reporter F. Stüssi (Switzerland), comprising six papers on properties of materials and ten papers on developments of methods of calculation. Then under "Metal Structures" we have group II, new developments of connections in metal structures, general reporter P. Dubas (Switzerland), with six papers on welding and four on prestressed high-strength bolts; and group III, the steel skeleton, general reporter G. Winter (U.S.A.), comprising seven papers on design and execution, two on slabs and walls and two on erection and safety of workmen.

Under "Reinforced and Prestressed Concrete," group IV, whose general reporter is H. Louis (Belgium), covers new developments in bridge building with four papers on progress and failures in bridge building, and four on safety; and group V, general reporter G. Wästlund (Sweden), covers prefabricated structures with two papers on connection methods and two on redistribution of stresses due to creep.

Later on a "final report" on the congress will be published. It will contain the discussions which have been in progress this week, as well as those papers submitted to the congress dealing with practical applications and special problems.

Water Pollution Research in 1959

THE Water Pollution Research Laboratory at Stevenage is being extended and in the Laboratory's report for 1959 it is stated that work has started on a new wing, scheduled for completion early next year, which will accommodate an additional forty research staff and increase the total research effort of the Laboratory by nearly 50 per cent. Most of the new accommodation will consist of pilot-scale laboratories in which new experimental methods of treating waste liquors can be taken to the stage where they can be introduced into full-scale practice.

A new experiment was started last year in a large pilot plant in the open air, in which four of the media now most commonly used in percolating filters (clinker, blast-furnace slag, broken rock, and gravel), each in two sizes, are being used to treat purely domestic sewage under controlled conditions. In the first period of four months last summer, during which the filters were becoming matured, there were very large differences in efficiency between the different types and sizes of materials. At one stage, for example, 1in gravel and blast-furnace slag was bringing about almost complete oxidation of ammonia whereas no appreciable nitrification was occurring with 2½in rounded gravel. Using radioactive tracers, efficiency is being correlated with the period of retention in these filters.

Further investigations have been made on the treatment of a number of industrial waste liquors, including those from meat processing, tanning, wool-scouring, electro-plating, and the purification of coke-oven gases. Many of these investigations have been made at the request of manufacturers and on a repayment basis—a service which has grown considerably during the year.

Work continued during the year to determine the relative efficiency of aeration in the activated-sludge process by different means, including diffused air, rotating brushes, and "Simplex" aeration units, and with the effect of various factors, including the presence of synthetic detergents, on performance.

THE LUTON DETERGENT EXPERIMENT

With the aim of solving the numerous public health problems caused by the introduction of synthetic detergents, large-scale tests on a material have been carried out during the year for the Standing Technical Committee on Synthetic Detergents, who recently published their third progress report. This work was commented upon in a report last week of the Institute of Sewage Purification's conference. First results show that household washing powders, containing the new, "soft" form of surface active material, developed by the manufacturers, are more easily decomposed by bacterial action.

Following promising results from pilot plant investigations made at the Laboratory, in August, 1958, the manufacturers started to supply the Luton area, through normal trade channels, with detergents containing the new surface active material. By the end of 1959, 70 per cent of the powder used in the area was of the new type. In conjunction with the laboratory of the Government Chemist the Water Pollution Research Laboratory made a systematic examination of the removal of surface-active matter during treatment of the town's sewage at the Luton works. The results were again encouraging, the proportion removed being increased by about the amount expected from the pilot-scale trials. The new detergent is now to be supplied to a much larger area in the South of England to help towards a decisive conclusion to the experiment.

Stafford By-Pass

NEARLY 5 miles of motorway, with twenty-four bridges and a ¾-mile "all-purpose" road, by-passing Stafford, are to be built in the next twenty-three months. Mr. Ernest Marples, Minister of Transport, has authorised Staffordshire County Council, as his agents, to accept John Laing and Son's tender of £2,680,000 for this and associated works, the second contract in the Stafford by-pass project. The first contract was let in August last year to J. L. Keir and Co., Ltd., for the construction of the Creswell Viaduct, which is about ½-mile long, and will carry the motorway over the main Stafford to Crewe railway line and the valley of the River Sow. The viaduct works, now well in hand, were started before the main roadworks in order that both should be completed together.

South of Stafford, the by-pass will begin at the Wolverhampton–Stafford Road (A.449) just north of the village of Dunston. It will then run to the west of the built-up area of Stafford, skirting Stafford Castle, and will end at the Stafford–Stoke Road (A.34) just north of Stafford itself. The twenty-four bridges to be constructed on the by-pass include two over railway lines; and 1,000,000 cubic yards of material will have to be excavated. The 4¾-mile motorway section will have dual 36ft wide carriageways, separated by a 15ft wide central reservation. It will run from Dunston to the northern end of the Creswell Viaduct, and will form part of the Birmingham–Preston motorway M.6. The ¾-mile length of "all-purpose" road, with dual 24ft wide carriageways, will link Creswell Viaduct with A.34 and complete the by-pass of Stafford, providing a convenient connection between the motorway and Stoke and the Eastern Potteries. A two-level roundabout will be built at Eccleshall Road (A.5013) at the junction of the motorway and the "all-purpose" road. The works have been designed for the Ministry of Transport by the agent authority, Staffordshire County Council, whose county surveyor is Mr. F. Jepson.

Coal Fired Power Station Programmes

THE Government's decision to slow down the nuclear power generation programme brings into greater prominence the plans of the Central Electricity Generating Board for building coal-fired power stations. It means that previous plans for coal-fired plant for the years 1965 and 1966 must be increased by 1300MW. Moreover the load forecasts for 1965 and 1966 have been increased during the past year. On both counts, therefore, a much more vigorous programme of construction of coal-burning power stations is required than was envisaged a year ago and the C.E.G.B. is planning accordingly. Applications have been made earlier this year for statutory consents for a number of coal-fired stations, including two large new stations near the East Midlands coal field—one at West Burton and the other at Holme Pierrepoint near Nottingham, each of 2000MW capacity—and a somewhat smaller new station of 1400MW capacity at Tilbury. Tenders for the relevant generating plant are already being sought and the Board states that, provided the Minister of Power gives his consents before the end of this year, enough coal-fired plant can be provided to compensate for the cut in nuclear power plant and to cater for the estimated growth of demand in 1965 and 1966.

Signals Training for Civil Aviation

AN open day was held on June 27 at the Ministry of Aviation's Civil Aviation Signals Training Establishment, Bletchley. Exhibits of the apparatus used for the instruction of trainees presented a comprehensive picture of current practice in ground and airborne equipment for communications and navigational aids, and included such recent introductions as the Marconi AD210 automatic direction finder for ground stations, and the new STAN 7-8-9 ground ILS equipment of Standard Telephones and Cables, Ltd. In the Marconi d.f. set a signal derived from the receiving aerials is compared with a local reference to produce an output which actuates a pointer display. This may be switched to show magnetic courses to steer, magnetic bearings, or true bearings. The latest S.T. and C. ILS equipment is transistorised and was stated to be less liable to disturbance by reflections from buildings and other local features than existing installations.

The ground transmitter exhibit included a new m.f. beacon which is being installed as a localiser at airfields so that a position indication may be obtained on the aircraft m.f. equipment while the v.h.f. installation is in use for other purposes. Also in this section of the school a Marconi VOR beacon was shown, and a "Eureka" transponder beacon for providing range indication when interrogated by an aircraft. The proposed DMET system to work in conjunction with VOR beacons will be a similar transponder device, but working on a higher frequency and operating a meter in the aircraft instead of a c.r.t. display.

A feature of the basic electronic training at the school is the use of "breadboard" chassis on which units carrying various combinations of resistances and capacitors, or valveholders with their connections brought out to terminals, are readily mounted. Complete circuits can then be wired up by interconnecting the units, which have spring terminals in order to simplify and speed up the procedure. Simple timebases are wired up by beginners in this way and their operation studied, so that pupils are familiarised from the beginning with the operation and use of oscilloscopes. A knowledge of radio fundamentals and the ability to solder two wires together are said to be the minimum required of entrants to the school.

Wideband Amplifier for Marine Transmitters

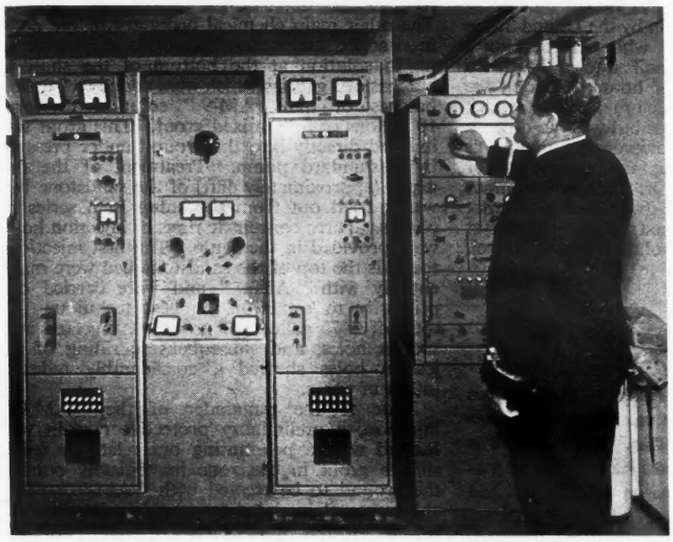
AN application of the form of wideband h.f. amplifier described in our August 21, 1959, issue (page 112) has been made in the G.P.O. cable-laying ship "Monarch," where two such amplifiers are operated in parallel to provide a peak envelope power of 2·8kW on single sideband working when driven by the primary stages of a 1kW independent sideband h.f. transmitter. The maker of the equipment, Marconi's Wireless Telegraph Company, Ltd., Chelmsford, Essex, believes this to be the first ship's h.f. installation in the world to embody a main amplifier having no tuned circuits. Substantially constant power gain is provided over the whole band from 1·5 to 24 Mc/s without any adjustments to the amplifier when the working frequency is changed. The accompanying illustration shows the two amplifiers mounted on each side of a central frame, housing a switching unit, coil unit, c.r.t. monitor unit for showing the r.f. output waveform, and r.f. load units with r.f. power measuring probes. One of the two Marconi "NT201" transmitters, which may be used with the amplifier, is seen on the right. Either or both transmitters can also be operated independently of the amplifiers.

Each amplifier consists of a penultimate and a final stage. Input is by a 70-ohm coaxial cable and the signal is converted to a push-pull device for the penultimate stage by means of a ferrite core transformer. The penultimate stage consists of a distributed amplifier using nine pairs of "E180F" valves operating in class "A". The anode load for each pair is a chosen impedance at a particular point in a balanced transmission line consisting of lumped constants. A similar transmission line is used in the grid circuit of the valves. The signal is fed to the final stage via a ferrite-core transformer which provides 70 ohms output impedance, and is again converted into a push-pull input for the final amplifier stage, consisting of another distributed amplifier in which eight pairs of 4 × 205B air-cooled tetrodes work in a linear mode approaching class "A."

A power indicator drive unit provides a signal proportional to the instantaneous forward power output of the transmitter; this operates the p.e.p. indicator meter. Pulse lengthening is introduced into these circuits so that the indicator system has a quick rise time and long delay, permitting accurate observation of forward peak envelope power during normal operation on traffic. Mounted alongside the p.e.p. indicator is another meter which indicates the voltage standing wave ratio on the feeder and also the load absorption factor—that is, the proportion of forward power absorbed by the load.

The amplifier supply control circuits are locally controlled, but the amplifiers may be opened up or closed down to traffic from the remote position. Indication of whether the equipment is "unready," "ready" or "busy" is provided by lamps, whilst the r.f. indicator and voltage standing wave ratio meters are duplicated at this position. The "NT.201" 1kW transmitters can also be brought from "standby" to "operational" condition from the remote control position, and also operated from there.

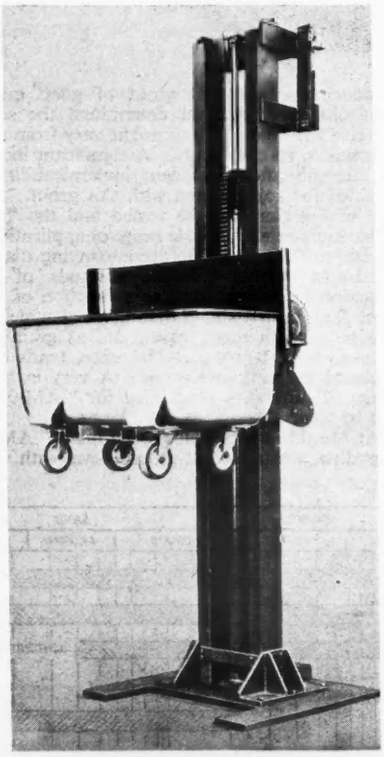
[Reply Card No. E371]



Assembly of two wideband h.f. amplifiers in the Post Office cable ship "Monarch" and, on the right, one of the transmitters by which they may be driven

Elevating and Tipping Equipment

PARTICULARS of a new hopper elevating and tipping equipment have just been received from Conveyancer Fork Trucks, Ltd., Liverpool Road, Warrington. This equipment, illustrated below, consists of a fabricated steel baseplate to which are bolted two braced vertical steel channels having set between them a hydraulic elevating cylinder. A chain passing over a pulley at the top of the piston of this cylinder is connected at one end to a rear cross brace of the channel uprights and at the other end to a carriage assembly which is free to slide up and down the channels on rollers. A tilting section on the front of this carriage carries a set of load forks and has on the back at each side a toothed gear segment. These segments are designed to mesh with racks at the top of the vertical members.



Hydraulically operated elevating and tipping equipment for hoppers or other containers

When operating the equipment a loaded container is wheeled into position on the load forks and, on pressure fluid being admitted to the cylinder, the forks are raised through the piston-rod and chains, as shown in the illustration. As the carriage nears the top of the channels the gear segments engage the racks to impart a tilting action which is completed at the top of the lift. At the extremity of the tilting movement a limit switch is depressed and the motor driving the hydraulic system pump is stopped. The time the carriage remains tilted can be pre-set to last up to three minutes, after which an electro-hydraulic valve opens and the carriage begins to descend with its tilting section being restored to normal level as the segments pass down the racks. This initial return movement is effected at a reduced speed, by restricting the oil flow through a valve, until the carriage leaves the rack when the rate of descent is speeded up to a pre-set maximum.

At the bottom of the channels the carriage depresses a limit switch which stops its movement and re-sets the controls to the starting position ready for the next operation. Depending upon the load requirements single or double hydraulic elevating cylinders are fitted.

[Reply Card No. E372]

200A Welding Generator Set

A TWO-CYLINDER air-cooled diesel engine drives the welding generator set in the "SA200" mobile unit (illustrated) which was introduced recently by Lincoln Electric Company, Ltd., Welwyn Garden City, Herts. The engine is a "2YWA" Ruston and Hornsby unit developing 21 b.h.p. at 200 r.p.m. and the generator is designed for an output of 30A to 275A hand welding current, or 200A continuously. The set supplies uniform welding current for metallic arc welding with bare or heavily-coated electrodes or for carbon arc welding. The open-circuit voltage can be adjusted in a continuous sequence by means of a shunt field rheostat, whilst control of welding current is effected by adjustment of both the series and shunt fields. The generator field rheostat and current regulating switch are mounted on a vertical steel control panel, and terminals with wing nuts are provided on this panel to facilitate changing of the polarity of the welding current. The generator is mounted directly on to the engine bell housing and is driven through a coupling connected to the flywheel by means of "Silentbloc" flexible bushes.

The new unit can be supplied with four small diameter wheel running gear or with two large diameter wheel running gear complete with screw jacks and jockey wheel for fast road towing.

[Reply Card No. E373]

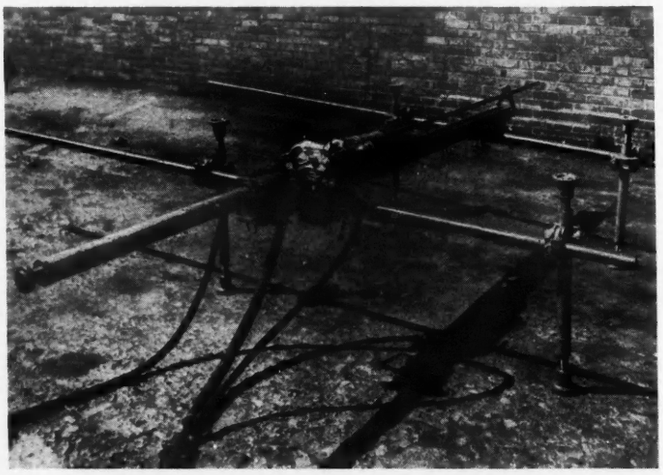
"SA-200" mobile welding generator with standard four-wheel running gear. Welding current range 30A to 275A

SHORTER REPORTS *(Continued)*

Portable Thruster Rig for Rock Drills

A THRUSTER rig for use with rock drills on long hole stope drilling has been developed by Holman Brothers (Proprietary), Ltd., of Johannesburg, a subsidiary of Holman Brothers, Ltd., Camborne, Cornwall. This rig is designed to meet a need for an accurate, compact and easily portable long hole driller for use in limited space and headroom on flat and narrow stopes. It can be dismantled easily for movement between faces and no spanners or special tubes are required in dismantling or assembly.

As can be seen in the illustration the equipment has a lightweight tubular steel frame with screw end jack bars for height adjustment purposes. The drill feed equipment consists essentially of a pneumatic cylinder and piston assembly, similar to a retractable air-leg, mounted on a slide rail behind the drill. This slide rail is supported on the tubular cross members of the frame. Two air passages are provided in the piston-rod, one passage admitting air behind the piston for forward movement and the other supplying air to the front of the piston for its retraction. The pneumatic cylinder assembly can also be moved backwards and forwards in a slide in successive stages in drilling operations.



Thruster drill rig developed for use in long hole stope drilling. The rock drill is in the extreme onward position on the slide rail and the cylinder protrudes through the slide gate collar ready to begin the first stage feed of the drill

In using this rig when the cylinder is in the extreme outward position away from the rock face and the piston is fully withdrawn inside the cylinder, air admitted behind the piston pushes the piston-rod towards the face and provides the first stage feed for the drill. To re-set for the next feed stage when the piston is fully extended a control valve is operated to admit air in front of the piston. The piston with drill attached remains stationary, because of the weight of the drill and the frictional resistance of the drill steel in the rock, whilst the cylinder mounted in a collar slide is then drawn towards the face. When the cylinder has moved up to the end of the piston-rod, a gravity-operated slide gate on the cylinder slide locates in an annular groove on the outward end of the cylinder body. This slide gate prevents the cylinder moving back when air is again applied behind the piston to start the next stage of drill feed. To withdraw the drill the feed sequence is reversed.

[Reply Card No. E381]

A Chemical Grout

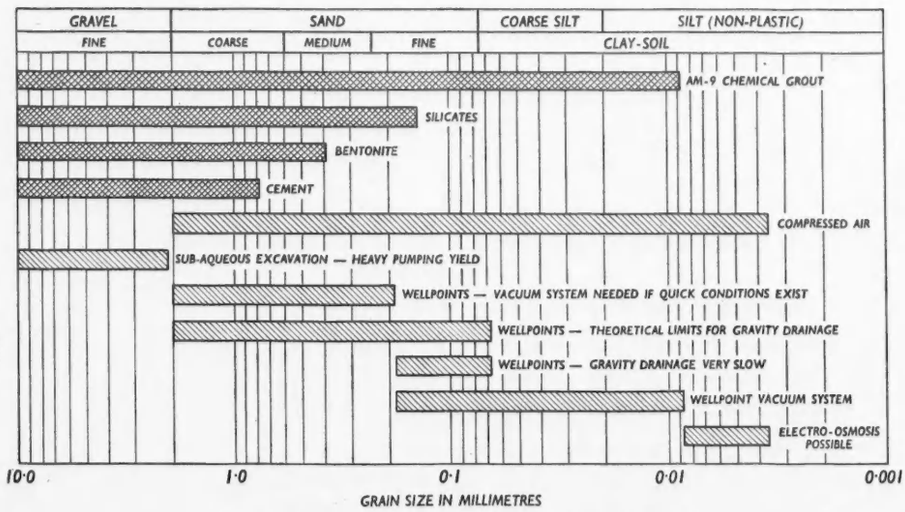
A CHEMICAL grout known as "AM–9" has been introduced into this country by Cyanamid of Great Britain, Ltd., and has been used by the Cementation Company, Ltd., to seal porous sandstone in a shaft sinking operation at the National Coal Board's Monkton Hall colliery in Midlothian. Development of the new grout arose out of an investigation by the United States Army Corps of Engineers who were seeking a chemical spray to turn soil into a hardened airstrip within a matter of hours. Among the compounds tested was calcium acrylate, which proved effective in field trials but was too difficult and costly to apply. However, although this idea was dropped, development continued for another seven years under Dr. Swift, of the parent Cyanamid Company; Dr. Swift discovered that calcium acrylate combined with a catalyst changed from an aqueous solution into a stiff gel, producing a chemical grout of good quality. The choice of catalyst determined the setting time of the "gel," which might vary from a few seconds to several hours. A significant increase in strength and permanent impermeability are claimed for soils treated with this grout. Since the setting time can be varied and the "sol" behaves like water, a wide range of applications is clearly obtainable. The accompanying diagram illustrates various possible methods of construction in porous soils, as a function of grain size. This clearly shows that alternative methods can be used in many cases, and as grain sizes reduce, cement grout, for instance, tends to be replaced by bentonite grout. A very extensive range of suitability is claimed for "AM-9" as can be seen.

At Monkton Hall colliery the main "AM-9" ingredient was mixed at ground level with water and part of the catalyst chemicals and delivered to a holding tank at the bottom of the shaft. The other main chemical necessary to the polymerisation, ammonium persulphate, was made up in solution at the bottom of the shaft in batches of 5 gallons which were added to 5-gallon batches of the "AM-9" solution to form 10 gallons of fully mixed grout. This grout was injected directly into the ground under pressure by a standard pump. Treatment of the full depth (approximately 48ft) of the sandstone bed was carried out from the sump in a series of phases. Three concentric rings of injection holes were provided in the sump. The first injections towards the top of the sandstone bed were made entirely with "AM-9" and were carried out primarily to establish the best technique. A total of 3470 gallons of grout was injected into sixteen holes, and subsequent redrilling of injection holes showed a considerably reduced inflow of water.

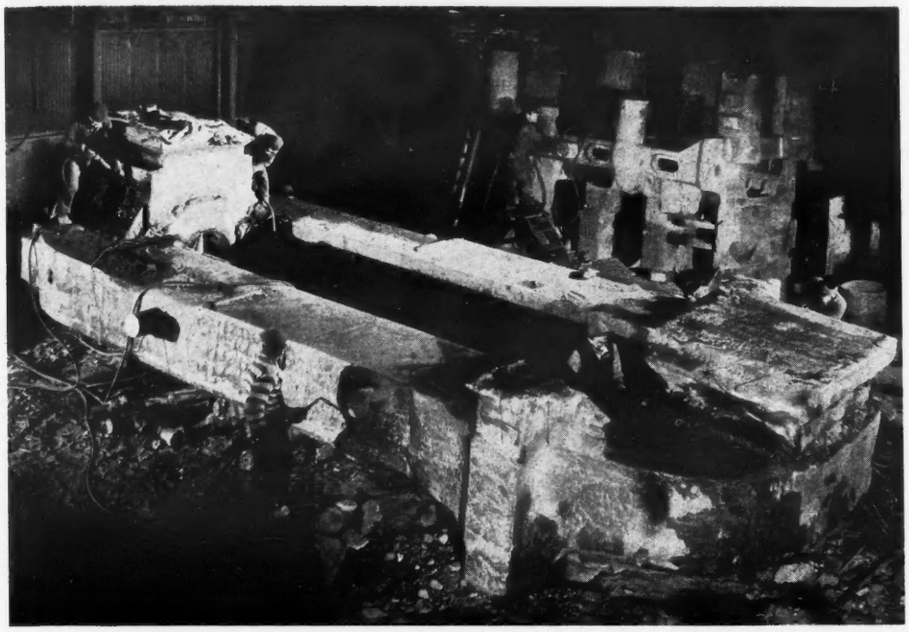
Prior to the remainder of the "AM-9" injection, a preliminary protective curtain was formed with a penetrating but relatively weak silicate grout in the zone immediately outside the ground to be treated with "AM-9." This envelope was intended to provide a barrier that would prevent undue loss of the "AM-9" through any particular open fissures that might exist. One hundred gallons of "AM-9" grout were injected in each of the second series holes in the section 20ft to 40ft below the sump. Gel-time was half an hour. Injection rates were from 2 to 4 gallons per minute. Pressures at the end of injection varied from 1300 lb to 2500 lb per square inch. In the series III holes, the grout volumes injected ranged from nil to 300 gallons per hole and in the series IV holes ranged from nil to 400 gallons per hole.

Before injection the water flow into the sump from the open holes drilled to 60ft depth was 144 gallons per minute. When the shaft had been sunk through the full depth of the bed of sandstone the water make from the wall was roughly 40 gallons per minute. Of this it is estimated that about two-thirds came from above the sandstone bed or from the upper part of the bed into which the injection stand pipes were fixed and which did not receive treatment. On the basis of these figures, inflow was reduced to about one-tenth. The volumes of inflow after excavation were from the full bore of the shaft in the porous rock, however, while the inflow from the drilled holes was from pipes of 2in diameter. It is suggested, therefore, that the flow resistance of the sandstone was increased by "AM-9" treatment in greater measure than the figures showed.

[Reply Card No. E382]



Comparison of methods for stabilising and dewatering soils



180-ton mill housing being fettled

Equipment for Aluminium Works at Kitts Green

In our issue of February 26 we gave general particulars of the programme of re-equipment which James Booth Aluminium, Ltd., had in hand to enable the works to meet future demands for aluminium alloy plate and sheet. Work is now proceeding with the components of the new mill, which is the responsibility of the Loewy Engineering Company, Ltd., and the English Steel Castings Corporation has recently completed the pouring of the first of two 180-ton housings at its Grimesthorpe foundry, Sheffield. In all a total of 250 tons of steel was used and three Siemens open-hearth furnaces supplied the 213 tons of grade "A" quality steel, at about 1650 deg. Cent., required for the initial pouring, while an additional 37 tons were added through the two feeder heads at intervals of two, four, six and eleven hours. The casting which was fettled and the two feeder heads, each weighing 35 tons, were cut off after a cooling period of about four weeks and the finished casting weighs 180 tons and measures 35ft 9in in height by 15ft wide and is up to 8ft 7in thick. Following annealing and other operations it is expected that the casting will be ready for transportation to The English Electric Company, Ltd., at Netherton, Liverpool, for machining previous to delivery and installation at Kitts Green Works. Our illustration shows the mill housing casting being fettled.

A film has been made of the casting operation and includes views of the pattern, for the building of which about 10·5 tons of timber were used, the construction of the mould and preparations made to make ready for the pouring of the metal. At the Kitts Green works preliminary work is now in hand including excavations in preparation for laying the foundations for the new mill and a co-ordinated programme for re-siting existing machines to accommodate the new production schemes and at the same time maintain output.

With the mechanical part of the scheme now in hand James Booth Aluminium, Ltd., has placed the contract for the electrical equipment for the 148in four-high hot mill and the 72in four-high cold strip mill, with The English Electric Company, Ltd. The contract, to the value of £500,000, includes the main motors for both the mills and the edging mills, and the plate shear, which is capable of shearing aluminium alloy plate 105in wide by 4in thick, as well as ancillary motors, converting equipment, control and switchgear. For the hot mill there are two 0/1500/1500 h.p. R.M.S. 0/175/500 r.p.m. d.c. motors which drive through a common gear unit to give a rolling speed of 280ft per minute. One 0/600/600 h.p. R.M.S. 0/175 r.p.m. d.c. motor drives the edger mill, while the shear drive consists of two 375/750 h.p. R.M.S. 360/720 r.p.m. d.c. motors. Power supply for the main drive motors is by a conventional Ward Leonard Ilgner set, consisting of one slip-ring induction motor developing 4200 h.p. at 750 r.p.m. and five d.c. generators, two rated at 1200kW, 550V, two rated at 600kW, 460V, and one of 480kW, 570V. There is one main motor rated at 2000 h.p. at 300/600 r.p.m. for driving the cold mill, and two coiler motors, each of 400 h.p. at 250/750 r.p.m. For supplying power to the main drive and coiler motors there is provided a motor generator set which includes one a.c. synchronous motor of 2750 h.p. at 1000 r.p.m. and four d.c. generators, two at 800kW and two at 320kW.

[Reply Card No. E391]

Electric Fork Truck

In designing its new "Rapide" range of electric fork trucks, Lansing Bagnall, Ltd., Basingstoke, Hants, has provided a unit capable of outdoor work at speeds of 12 to 14 m.p.h. as well as normal indoor service. This flexibility has been achieved by a control system having a weak-field step for top speed and automatic reversion to full-field when demanded by the load. The traction motor is a compound-wound machine with a one-hour rating of 10 h.p. at 1400 r.p.m. to B.S. 1727/1956. Only the series field winding, which is sectionalised, is used for traction, the shunt winding being for rheostatic braking, and coming into action automatically on the low-speed steps of the controller when the driver lifts his foot off the acelerator pedal. Six speed steps forward and reverse are obtained with minimum loss of energy in the resistances by using a limited number of armature resistance steps and deriving control mainly from parallel/series connections of the 48V "Exide Gauntlet" battery followed by series-parallel grouping of the field winding sections for top speed. In heavy load conditions on notches 1 to 5, when maximum motor torque is exerted, a switch operated by torque reaction automatically reconnects the field winding sections in series to restore full field.

The six speed steps are selected by electro-magnetic contactors energised through the cam-operated microswitch contacts of a controller actuated by the accelerator pedal. A dashpot filled with a silicone fluid governs the rate of operation of the controller to ensure smooth acceleration. A footbrake pedal controlling hydraulic brakes is the only other drving control. A handbrake for parking is provided forward of the driver's seat and the forward/reverse lever is near his left hand. Either brake isolates the traction circuit when operated. Lift, tilt and other hydraulic controls are fitted to the scuttle alongside the steering column. The lift and tilt motions are powered by a Plessey gear pump driven by a 6½ h.p. compound motor.

[Reply Card No. E392]

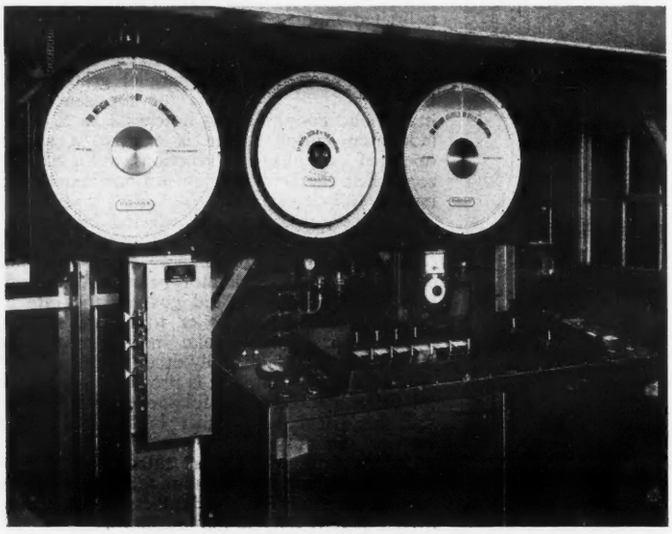
Telephone Developments in Scotland and Midlands

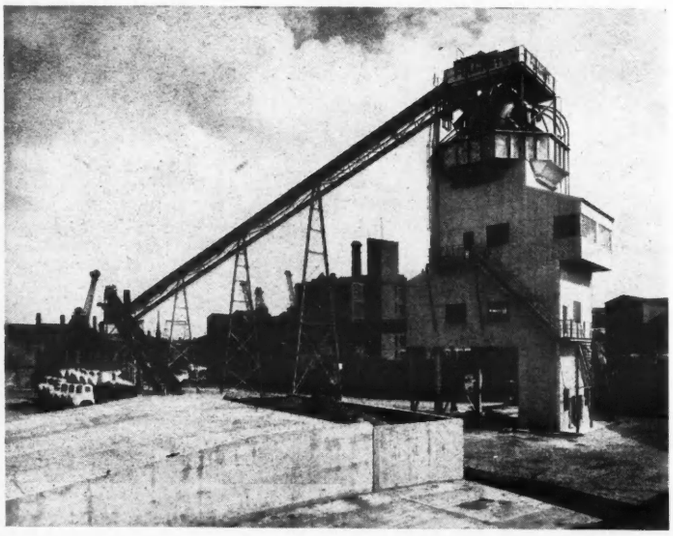
The first subscriber trunk dialling telephone exchange to come into operation in Scotland was opened on June 14. The equipment was installed by A.E.I. Telecommunications Division, 155, Charing Cross Road, London, W.C.2, and has 6500 lines and thirty-six manual positions. It is housed in a new building at Willison Street, replacing the automatic exchange at Dundee Head Post Office which, set up in 1924 with American equipment, was one of the oldest in the country. The range of calls which Dundee subscribers can dial direct includes London, Manchester, Glasgow, Edinburgh and Aberdeen.

Another inauguration, described as one of the major telephone projects in the Midlands, took place on June 11, when a new telephone exchange at Walsall replaced two older exchanges. The equipment here was also installed by A.E.I. Telecommunications Division. With the change of all Walsall numbers to new five-digit numbers, subscribers in Walsall and district can now dial calls to centres within an average radius of 20 miles, including Birmingham, Bridgnorth, Dudley Kidderminster, Stourbridge and Wolverhampton. Altogether, subscribers on over ninety exchanges are available by direct dialling. The new exchange is upgraded to group centre status, which means that all trunk calls from Walsall and district, formerly set up by Birmingham operators, are now set up by Walsall.

Battery-operated fork truck for normal indoor service or outdoor work on rough ground with gradients up to 1 in 5

SHORTER REPORTS *(Continued)*





(Left) The control panel of the plant and the weighing dials for fine aggregates, cement, and coarse aggregates. (Right) The plant with ground hoppers and ramp in the foreground, and the conveyors from these hoppers to the left

Ready-Mixed Concrete Plant at Fulham

THE accompanying illustrations show a new concrete batching and mixing station built at Nacovia Wharf, Fulham, London, for Greenham Ready Mixed Concrete, Ltd., for supplying the surrounding area with ready-mixed concrete from the company's own radio-controlled fleet of vehicles. At present one 4-cubic-yard mixer is installed in the plant, but there is room for a second mixer, which would be supplied from the handling and weighing devices already installed, should the demand warrant its installation. With two mixers installed, the output of the plant in a ten-hour working day would be about 1500 cubic yards.

The demand for ready-mixed concrete has been growing steadily throughout the country over the past few years, but there are still only about half a dozen plants such as this one in London. The facilities provided by the plant are of the kind associated with the best practice in quality control as applied to concrete technology. They include a laboratory where "mix design" to a customer's requirements can be done, and where routine tests of water content in sand, and of cube strengths of concrete, to give only two examples, are carried out.

Cement is delivered in bulk directly to the silos (one of 60 and two of 30 tons capacity) in the main tower of the plant. Sand and gravel are delivered in tipping trucks from pits in West Middlesex. They are tipped from a 7ft ramp into one of four ground hoppers, each of which holds 50 cubic yards. The remotely-controlled gates of these hoppers feed a belt conveyor. This transports the material 85ft up, to one of six hoppers on the main plant, at the rate of 150 cubic yards an hour. Normally, six varieties of aggregate and three of cement are handled.

The total hopper capacity in the main tower of the plant is 300 cubic yards, made up of two 75 and four 37½-cubic-yard hoppers, grouped round the central cement silos. Each aggregate hopper and each cement silo is fitted with high and low level indicators which operate in a control cabin at the base of the plant. From this point, one man can operate the conveyor, the gates to the ground hoppers, and the pivoted distributor at the top of the plant, which will shoot the material from the conveyor belt to the correct hopper. Water is stored in a 2500-gallon tank on the ground, being pumped up to a 400-gallon tank on the plant.

Weighing of materials is carried out in four hoppers. Two hoppers are each of 16,000 lb capacity (for sand and gravel); one is of 3250 lb capacity (for cement) and one is of 2000 lb capacity (for water). The aggregates are discharged through radial gates and the cement through semi-rotary valves, all operated by pneumatic rams. The water weigher is not shown in our illustration of the control panel, since it is situated to the left of the main panel. It may be noted from this illustration that the mixes are weighed out by an operator who reads the weights on the dials; a "punched card" system of control, like the one described in an earlier article in this journal, has not been adopted in this plant.

The cement weigh-hopper has a preset automatic cut-out, and the sand weigh-hopper is fitted with a moisture meter, which in turn registers on the operator's control panel. From the weigh-hoppers the materials are fed either into a 4-cubic-yard tilting drum mixer, or into a chute direct to a truck mixer. The concrete plant was supplied by Winget, Ltd., and the conveyors by W. W. Brown, Ltd.

[Reply Card No. E401]

Carbide and Acetylene Plant in Northern Ireland

A PLANT for the production of calcium carbide and acetylene has recently been completed at Maydown, Londonderry, Northern Ireland, and was officially opened by Lord Chandos, the chairman of the Northern Ireland Development Council, on Wednesday, June 15. The plant, which was designed and built by British Oxygen Engineering, Ltd., for Carbide Industries, Ltd., occupies a site of about 60 acres, of which 25 acres have been developed, so that there is adequate room for expansion should that prove necessary and for which the design of the plant provides. The plant initially will produce about 50,000 tons of carbide per annum and the bulk of this will be converted to acetylene, which will be pumped to the nearby neoprene synthetic rubber plant of the Du Pont Company (United Kingdom), Ltd. The unconverted carbide will be packed in drums for export.

Coke and limestone, the two basic raw materials for the manufacture of carbide, are brought by sea and unloaded at a wharf which has been specially built at Lough Foyle for that purpose. An aerial ropeway, about ½ mile in length, transports the raw materials to the factory stockpile. In the first stage of the process limestone is burnt to lime in gas-fired kilns and the lime is transferred by a belt conveyor first to a crusher and then to bunkers. The coke, which is required to provide carbon to react with the lime, is dried to a low moisture content in rotary kilns and then stored in bunkers. Both the coke and lime are automatically weighed and fed in the proportion of 1 to 6 to a belt conveyor and passed to overhead bunkers from which they are fed by gravity to a carbide furnace which operates on the submerged arc principle. This is a totally-enclosed rotating furnace and the furnace gases after cleaning are used for firing the lime kilns. A temperature of over 2000 deg. Cent. has to be produced in the furnace in order to obtain a reaction between the coke and lime to produce calcium carbide. The white hot molten carbide is tapped from the furnace into cast iron cars, each of 1-ton capacity, in which the carbide is allowed to solidify. After three to four hours the solid ingots of carbide are removed from the cars and cooled for a further sixteen to twenty hours before being transferred by crane to the crushing plant. The crushed carbide is stored in bunkers under a blanket of dry, inert gas. From these bunkers the carbide is either fed to continuous acetylene generators, where it is mixed with water to produce the desired end-product, or it is ground and packed for export.

[Reply Card No. E402]

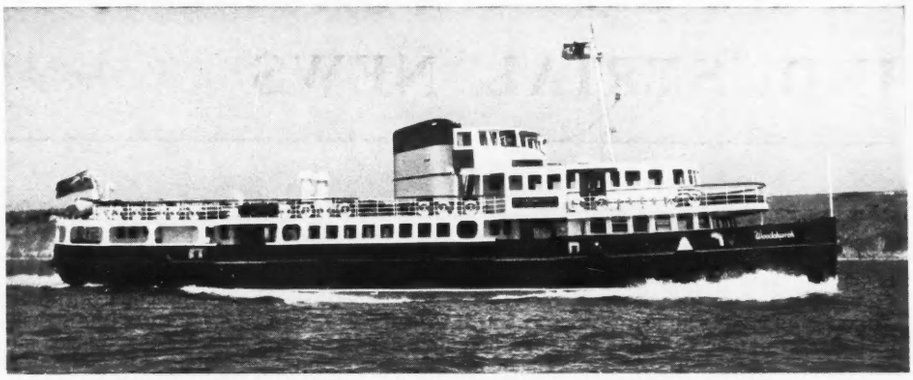
Launches and Trial Trips

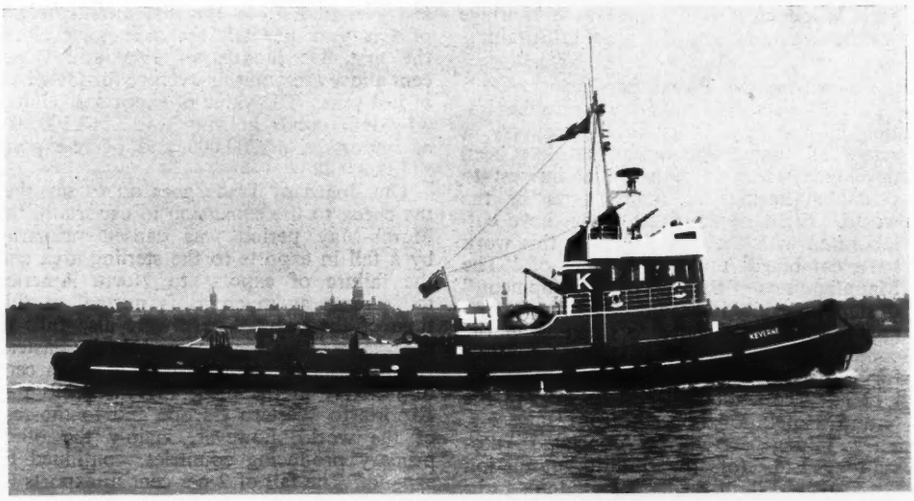
SAN CONRADO, oil tanker; built by the Furness Shipbuilding Company, Ltd., for Shell Bermuda (Overseas), Ltd.; length between perpendiculars 630ft, breadth moulded 87ft, depth moulded 45ft 6in, draught 34ft 2½in, deadweight 31,725 tons; thirty cargo oil compartments, one cargo pump room, four 900 tons per hour centrifugal pumps, four 150 tons per hour vertical stripping pumps, 13½in bore suction mains; two 600kW turbine-driven alternators, one 200kW diesel-driven alternator; one set of Metropolitan-Vickers double-reduction geared turbines, 12,500 normal s.h.p. at 105 propeller r.p.m., 13,750 maximum s.h.p. at 108 r.p.m.; two Foster Wheeler "D" pattern boilers supply steam at 600 lb per square inch and 850 deg. Fah, designed speed 15½ tons. Trial, March 23.

STIGMARIA, collier and ore carrier; built by the Chantiers et Ateliers de Provence for the Société Nationale d'Affretements Union Navale; length between perpendiculars 508ft 1in, breadth moulded 68ft 10in, depth to main deck 43ft 7in, draught 30ft 9in, displacement 23,020 tons, deadweight 17,500 tons; speed 14·3 knots; three 300kW 60 c/s diesel-driven alternators; Provence-Doxford 70 L.B.D.4.S oil engine, 7000 h.p. at 118 r.p.m. Trial, April.

Small Craft

The twin-screw Mersey passenger ferry "Woodchurch," on the RIGHT, was completed for the Birkenhead Corporation by Philip and Son, Ltd., and has a length between perpendiculars of 142ft 6in, a breadth of 39ft, a depth of 12ft 6in and a mean load draught of 7ft 3in. The ferry, which will be engaged on the Birkenhead–Liverpool service, has a Steam 5 Passenger Certificate for 1200 persons, for whom accommodation is arranged in three decks. Steering is effected by twin balanced rudders operated by electro-hydraulic gear, and there is a radio telephone for communication with shore based radar. Electric power for ship's services and auxiliary machinery

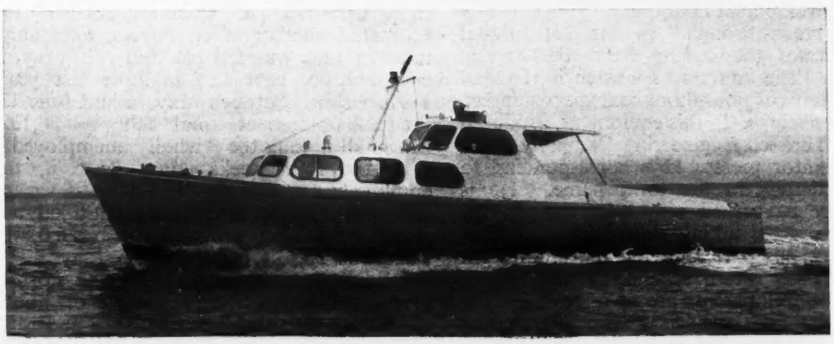




is provided by two 60kW diesel-driven generators and propulsion is by two Crossley "H.R.N." two-stroke diesel engines, each having eight cylinders and developing 680 b.h.p. at 350 r.p.m.; mean speed on trial 12·6 knots.

The fire-fighting tug "Keverne," on the LEFT, has been built for J. P. Knight, Ltd., for service at the B.P. Refinery (Kent) by John J. Thornycroft and Co., Ltd., at Woolston. Of 450 tons displacement the tug has the following main particulars; length between perpendiculars 110ft, breadth 28ft, depth 13ft 9in, draught extreme 14ft 9in, free running speed 12·9 knots, and static pull 28¾ tons. Fire fighting and salvage equipment includes two five-stage pumps capable of discharging water at 185 lb per square inch to four monitors mounted on the flying bridge, and eight deck hydrants. Two auxiliary diesel engines each drive a 40kW generator and a fire and salvage pump, and power for propulsion is developed by a British Polar two-stroke diesel engine. This is rated at 1650 b.h.p. at 330 r.p.m. and can operate down to 40 r.p.m. The engine drives the propeller through single-reduction gearing, having a ratio of 2 to 1, and the propeller works in a "Kort" steering nozzle, of 10ft 8in I.D., which can be rotated through 25 deg. to port or starboard and gives a steering circle diameter of just over 2¼ ship lengths.

Philip and Son, Ltd., built the high-speed launch "Landward," on the RIGHT, to serve in the Trinity House fleet of pilot vessels. The overall length is 70ft and the beam 16ft, and the hull is constructed of double skin mahogany with oiled calico between the planking, cathodic protection is provided, the deck is fitted with non-slip treads. There is a double cabin aft for the crew and a double cabin and day room forward for the officers. A diesel engine drives the generator, bilge pump, fire pump and a hydraulic pump and there are two 250-gallon fuel tanks. The main propulsion machinery consists of two Rolls-Royce diesel engines, each of 296 h.p. and driving through a Thornycroft 2- to -1 reverse/reduction gear.



On the LEFT is an aluminium alloy survey and patrol launch designed and built for the Belgian Government by Universal Shipyards (Solent), Ltd., for service on Lake Tanganyika. The launch is 40ft long by 11ft 6in beam and has a draught of 2ft 9in and the hull, which is built on the "two-way tension" system, is of 10 S.W.G. sheet. There are two 100-gallon fuel tanks and a cruising speed of 12 knots with a maximum of 15 knots is attained by twin Perkins "P.6." diesel engines, each developing 65 h.p. at 2000 r.p.m. and operating through direct-drive oil-operated gearboxes.

INDUSTRIAL NEWS

Engineering and Shipbuilding Wages

Last week, the Confederation of Shipbuilding and Engineering Unions held its annual conference at Llandudno. The resolutions dealing with wages in the engineering and shipbuilding industries were debated on Thursday and as a result a claim is being submitted immediately for an " unconditional general increase." The composite resolution on the subject was moved by Mr. William Carron, president of the Amalgamated Engineering Union, who asserted that wage rates in the engineering industry had never reflected the contribution of labour. He felt that wage restraint led to lower productivity and that wage increases encouraged increased productivity. An amendment to the resolution urged that the claim should be limited to increases on the minimum rates of all grades in the industries. The amendment was defeated, however, and the original resolution carried. At the same time, the Confederation's executive council was instructed by the conference to renew the negotiations with the engineering employers for a new wage structure in the industry. In addition, the conference resolved unanimously that the executive should continue to press for a forty-hour week.

Railway Wages

Last Friday, agreement was reached between the British Transport Commission and the three railwaymen's unions on wage increases, following the recommendations of the Guillebaud report. The report, it will be recalled, was presented at the beginning of March, since when negotiations as to the implementation of its proposals have been in progress. The report recommended that the salaried staff of British Railways ought to have an increase of approximately 10 per cent if a " fair relativity with outside employment " was to be achieved. For the conciliation grades, an increase of 8 per cent in the general level of wage rates was suggested, with differentials of 5 per cent, and for some groups 10 per cent, in addition to the general increase. The settlement reached last Friday appears to be on the lines of these recommendations and the increases are to be made retrospective to January 4. They will incorporate, of course, the 5 per cent interim increase made on January 11.

An official statement announcing the satisfactory conclusion of the negotiations again mentioned efficiency. It referred to the common desire of the British Transport Commission and of the trade unions " to convince the nation of their determination to promote the highest efficiency on British Railways." The statement added that an early meeting of the Railway Productivity Council would be held to discuss further steps which could be taken with that object in view.

Industry in Ulster

At a meeting of the Northern Ireland Development Council in London last week, the chairman, Lord Chandos, said that realising that productive capacity was getting filled up, the Ulster Government had geared its advance factory building programme so as to have factories ready this summer and suitable for a wide range of firms from Great Britain or abroad. He added that the five factories now waiting for firms to walk into them ranged in size from 18,000 square feet to 30,000 square feet. They were situated at Belfast, Coleraine, Strabane, Newry and Dromore. Five more, ranging up to 52,000 square feet, were nearing completion in the vicinity of Belfast. One of these was actually a triple-factory, capable of being divided into three small productive units. In addition to these new factories, Lord Chandos said, Northern Ireland had a surplus of adaptable male labour at a time when labour shortage was hitting many manufacturers in Britain.

Engineering for Postal Services

As a result of the drive for mechanisation by the Post Office in this country, a range of engineering equipment has been developed which is of potential interest to postal authorities in many parts of the world. Eight of the firms which have collaborated with the Post Office in this work have combined, under the name of " The Manufacturers of British Postal Equipment," to stage an exhibition of postal mechanisation appliances for delegates to the Eastbourne conference of the Consultative Committee for Postal Studies of the Universal Postal Union. The exhibition will be held in the Grand Hotel, Eastbourne, from July 5–7. Those taking part will be Associated Automation, Ltd. (of the Elliott-Automation Group) and Elliott Brothers (London), Ltd.; Harrison and Sons, Ltd. ; Setright Registers, Ltd. ; Sovex, Ltd. ; The Thrissell Engineering Company, Ltd. ; Vickers-Armstrongs (South Marston), Ltd. ; and Waterlow and Sons. The group was called into being at the suggestion of the Post Office. It is a free association of firms who are individually competitive but, without any formal association, are acting in concert in the interests of a new export industry which has already gained orders from Russia, Egypt and Switzerland. The members have also collaborated in producing for the exhibition an illustrated brochure in English and French describing their products. Its contents include the Sovex parcel sorting system at Leeds (described in our January 22 issue), the Thrissell letter sorting machine (see our August 15, 1958, issue, p. 260), and the Elliott segregating and grading machine. A review of some prototype machines for these purposes appeared in our May 3, 1957, issue. An outline of trends in this expanding field was given recently by Brigadier K. S. Holmes, Director of Postal Services in the G.P.O., who referred to the latest development in automatic letter sorting as a " break-through " in this field in that it separates the coding from the sorting process. The address as written is replaced by a pattern of phosphorescent spots stamped on the envelope. In this equipment, produced by the Thrissell Engineering Company, Ltd., the operator presses keys corresponding to certain letters in the town name. He is therefore concerned only with coding, the sorting process taking place without further action on his part after the phosphorescent pattern has been scanned electronically. Certain developments are of interest outside the postal field, such as a vertical conveyor invented by the Post Office which has applications in milling, shipping, and any industries requiring to convey packages of irregular shapes.

Overseas Trade

The Board of Trade's latest assessment of the overseas trade situation is that, in the three months March to May, the actual value of United Kingdom exports was 1 per cent less than in the preceding three months. The Board says that the rise in exports at the beginning of the year has not been maintained in recent months. But the substantial increase in exports during last year and up to the first month or two of this year has left the average level for the first five months of 1960 still 9 per cent above the monthly average for the whole of last year. The value of exports of United Kingdom goods in May was £317,500,000, of imports £389,700,000 and of re-exports £11,800,000.

The Board of Trade goes on to say that the check to the expansion in exports in the March-May period was caused primarily by a fall in exports to the sterling area and the failure of exports to North America to increase as much as is normal at this time of the year. There were also falls in exports to Latin America and Soviet Eastern Europe after increases of 16 and 21 per cent respectively in the preceding three months. Exports to Western Europe and to the rest of the world, however, mainly the other primary producing countries, continued to expand. The fall of 2 per cent in exports to the sterling area, the Board of Trade comments, was against the normal seasonal trend ; there had been increases averaging about 3 per cent in this period in all but one of the preceding six years. Exports to Australia again increased substantially (by 8 per cent) between March and May to a level 20 per cent above that of a year earlier and there was a small increase in exports to New Zealand.

In its analysis of the commodity groups, the Board of Trade says that the 1 per cent fall in United Kingdom exports in March-May was most likely attributable to food and fuels, with manufactured goods generally showing little change. Non-electrical machinery is described as the " main supporting element," although the 9 per cent rise in this category appears to have been seasonal.

Unemployment

The latest return from the Ministry of Labour shows that 305,044 people were registered as unemployed in Great Britain on June 13. Of that number, 297,079 were registered as wholly unemployed and 7,965 as temporarily stopped. The Ministry says that, expressed as a proportion of the estimated number of employees, unemployment in June was 1·4 per cent ; in May, it was 1·5 per cent and in June last year, 1·9 per cent. Between May 16 and June 13, the unemployment total fell by 36,132, nearly all among the " wholly unemployed."

In the four weeks ended June 8, the employment exchanges filled 144,106 vacancies, the number of vacancies notified but remaining unfilled on June 8 being 360,886. That was 33,619 more than in May. The Ministry of Labour says that the normal seasonal change is an increase of about 25,000. It adds that between April and May the actual change in the number of vacancies notified was an increase of 21,438 compared with a normal seasonal decrease of about 2,000.

PERSONAL AND BUSINESS

Appointments

MR. DESMOND R. STANLEY-ADAMS has been appointed export sales manager of the international division of U.S. Industries, Inc.

MR. JOHN C. HOLMES has been appointed export manager of Glass Yarns and Deeside Fabrics, Ltd., a member of the Microcell Group.

MR. J. D. D. MORGAN and DR. L. M. WYATT have been appointed to the research board of the British Welding Research Association.

MR. CHRIS CHARLES BLEACH, M.I.Mech.E., M.I.E.E., has been elected president of the South Wales Institute of Engineers for the session 1960-61.

WORTHINGTON-SIMPSON, Ltd., has announced the appointment of Mr. K. P. H. Jeens as manager, oil industries department, Queen's House, Kingsway, London, W.C.2.

MR. S. N. KINSLEY has succeeded Mr. Geo. H. Davison as secretary of the research and development department of the United Steel Companies, Ltd. Mr. Davison retired on June 30 but continues to serve in a full-time advisory capacity.

BOWMAKER (PLANT) Ltd., has announced the appointment of Mr. Douglas E. Speight to the new post of earth-moving representative. Mr. J. W. C. Hart has been appointed sales representative for Shropshire and north Staffordshire in succession to Mr. Speight.

THE SOCIETY OF BRITISH AIRCRAFT CONSTRUCTORS, Ltd., states that Sir George Dowty has been elected president of the Society for 1960-61, with the Hon. George Nelson as vice-president. Sir Aubrey Burke, president in 1958-60, becomes deputy president. Sir Frederick Handley Page has been re-elected treasurer.

HARLAND AND WOLFF, Ltd., announces that Mr. H. R. Humphreys and Mr. W. H. Park who retired from their executive positions on June 30, 1959, have resigned from the board of directors. Mr. J. A. Watt, a shipyard manager at the company's Belfast Works, and Mr. R. R. G. Cameron, M.R.I.N.A., the company's naval architect, have been appointed to the board.

MR. T. L. BEAGLEY has been appointed shipping adviser to the Commissioner General for South East Asia and the United Kingdom Commissioner for Singapore, and to the United Kingdom High Commissioner in Kuala Lumpur, in succession to Mr. A. M. Houghton who has returned to the United Kingdom. Mr. G. R. W. Brigstocke has been appointed shipping atttaché in Washington in succession to Mr. R. D. Poland who has returned to the United Kingdom.

F. PERKINS, Ltd., announces the following appointments : Mr. F. J. W. Rolt, managing director of its associate company Motores Perkins S.A., Sao Paulo, Brazil, has been appointed resident representative for the Perkins Group in South America. Due to these additional duties he has relinquished his appointment as managing director of the Brazilian company, but will continue to represent the parent company on the board. Dr. Manuel Garcia Filho, previously commercial director of Motores Perkins S.A., has been appointed managing director, and Mr. Charles F. Hill has been appointed to the Board as deputy managing director.

Business Announcements

SIMPLEX ELECTRIC COMPANY Ltd., Creda Works, Blythe Bridge, Staffs, has opened a new depot at Wyke Street, Hull.

SPENBOROUGH ENGINEERING COMPANY, Ltd., Union Road, Heckmondwike, Yorks, has changed its telephone number to Heckmondwike 1411 (5 lines).

LLOYD'S REGISTER OF SHIPPING has established an exclusive office at Port of Spain, Trinidad, which will be operated by Mr. J. L. Lumsdon, a surveyor transferred from New York.

BRITISH TIMKEN DIVISION OF THE TIMKEN ROLLER BEARING COMPANY states that its London office is now situated at 8, Grafton Street, London, W.1, (telephone, Hyde Park 1971-3).

SEMICONDUCTORS, Ltd., states that it has acquired from Sylvania Thorn Colour Television Laboratories, Ltd., the production equipment for the manufacture of n-p-n germanium power transistors.

TRANSPORT VEHICLES (DAIMLER), Ltd., announces that the manufacture of bus chassis at Radford Works, Coventry, will continue after the acquisition of the Daimler Company, Ltd., by Jaguar Cars, Ltd.

AVELING-BARFORD GROUP OF COMPANIES announce that their London manager, Mr. C. G. Miller, having reached retirement age, ceased full time duty on June 30. He remains in Group service as a consultant.

ATOMIC POWER CONSTRUCTIONS, Ltd., and the G.E.C.-SIMON-CARVES ATOMIC ENERGY GROUP state that as a result of further discussions between the companies, they have now agreed to join forces to design and build nuclear power stations in this country.

WESTLAND AIRCRAFT, Ltd., announces that its Saunders-Roe Division is continuing to collaborate with Hovercraft Development, Ltd., and that as a joint venture the firms are building "SR-N2," a multi-engined 25-ton craft to carry sixty-eight passengers at up to 70 knots.

HARNISCHFEGER CORPORATION, 4444, W. National Avenue, Milwaukee 46, Wis., has appointed Maquinas y Herramientas, Sabin St. Germain, S.A., Marsella y Dinamarca No. 72, Mexico 6, D.F., Mexico, as distributor for the sale of P. and H. electric hoists and overhead travelling cranes. The territory covered includes the entire southern portion of that country.

STRATOFLEX INC. has announced the formation of Stratoflex (U.K.), Ltd., 11, Colquhoun Avenue, Hillington, Glasgow, S.W.2. The new company will produce aircraft and industrial flexible hoselines and related fluid power products and will supplement the existing selling organisation in most European countries, and the Commonwealth. Mr. T. G. Preston will be managing director of the new company.

MERCANTILE CREDIT COMPANY, Ltd., Argyll House, 246-250, Regent Street, London, W.1., has announced the formation of a new company, Mercantile Leasing Company, Ltd., for the leasing of new machinery and equipment, fleets of cars and vehicles, &c. United States Leasing Corporation of San Francisco will be a partner in this enterprise with a 20 per cent holding, subject to Bank of England exchange control permission, which has not yet been obtained.

HAWKER SIDDELEY INDUSTRIES, Ltd., is to establish a new research centre, costing over £200,000, at Stockport. The centre will provide basic research and development facilities in a single establishment for both the heavy diesel engine companies of Mirrlees, Bickerton and Day, Ltd., and the National Gas and Oil Engine Company, Ltd. The centre will be directed by Dr. Joseph Albert Pope, M.I.Mech.E., who joins the boards of directors of both the Mirrlees and National Companies.

ELLIOTT-AUTOMATION, Ltd., 34, Portland Place, London, W.1, announces that it has entered into an agreement with Hallikainen Instruments of Berkeley, California, under which it will exploit the range of automatic analytical control instruments developed by the Shell Research Laboratories at Emeryville, California, for the petroleum, petro-chemical and chemical industries and manufactured under licence by Hallikainen. Hallikainen Instruments will supply the North and South American markets and Japan with these instruments and Elliott's the rest of the world. A new Elliott-Automation subsidiary company, Hallikainen Instruments, Ltd., is being formed in London to handle the new business.

Contracts

HEENAN AND FROUDE, Ltd., Worcester, has received an order from Brodogradiliste Uljanik, Pula, Yugoslavia, for a size F.A.16 Froude hydraulic dynamometer capable of absorbing and measuring up to 20,000 h.p. at speeds ranging from 115 to 225 r.p.m.

EKCO ELECTRONICS, Ltd., has received an order from the Central Electricity Generating Board for eighty-six radiation monitors. They will be used at the Board's new nuclear power stations at Berkeley, Bradwell and Hinkley Point and are all portable, battery-operated instruments.

RUSTYFA, Ltd., announces that after negotiations with the trade delegation of the U.S.S.R. in the United Kingdom it has concluded an addition to its contract with Techmashimport of Moscow, value £1,000,000. This covers the anticipated requirements for spare parts for the tyre factory being erected at Dniepropetrovsk in the U.S.S.R. and makes the total of orders so far received for this project approximately £16,000,000. As on the original contract Dunlop Advisory Service are acting as Consulting and Advisory Engineers.

MAWDSLEY'S, Ltd., has received an order for electrical equipment on the railway wagon marshalling system being supplied by Strachan and Henshaw, Ltd., Bristol, for the new steel works for Richard Thomas and Baldwin, Ltd., at Llanwern, Newport, Monmouthshire. This equipment includes 40 b.h.p. motors for operating the Strachan and Henshaw patented "Beetles," which move selected wagons or rakes of wagons used in the handling of coke and concentrates, coal, home ore and foreign ores, and the 200 b.h.p. Ward Leonard variable speed control for wagon tipplers.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., announces that an order for £500,000 worth of telephone equipment has been received by A.E.I. Telecommunications Division from the Australian Post Office. It involves supplying trunk telephone switching equipment and voice-frequency signalling equipment for the Australian automatic trunk switching system in New South Wales, Victoria, Queensland, South and Western Australia, and Tasmania. Altogether the apparatus will incorporate nearly 10,000 relay sets of various types and approximately 3000 motor uniselector switches. Delivery will commence early in 1961.

HEAD WRIGHTSON STOCKTON FORGE, Ltd., is supplying to Richard Thomas and Baldwins, Ltd., six rotary dryers for an iron ore drying plant costing approximately £240,000. Three of these machines, each of which measures 45ft long by 10ft in diameter, will be installed at the Redbourn Works and three at the Spencer Works of Richard Thomas and Baldwins, Ltd. Each installation is capable of handling a weekly output of 21,350 tons of ore processing from 0in to 2½in. The rotary dryers are arranged in parallel flow and each has a rated capacity of 50 tons an hour when drying from 20 per cent moisture down to 9 per cent.

HOLLAND & HANNEN AND CUBITTS (GREAT BRITAIN), Ltd., has been awarded a £130,000 contract for the Southborne Cliff Works at Bournemouth. Work is to start in August, subject to Ministry of Housing and Local Government approval. The contract, due for completion in February, 1962, provides for the continuation of the existing line of coast protection. A 1150ft sea wall is to be constructed in steel-sheet-piling and stone-faced reinforced concrete, with an access road along the foot of the cliffs. An approach road down the cliffs is to be constructed with a slope of 1 in 10 and three groynes in prestressed concrete will run 130ft into the sea. The contract also provides for some cliff trimming and stabilisation, and drainage works associated with the access roads. The work is under the direction of the Borough Engineer, M. E. C. Whitaker, A.M.I.C.E.

BRUCE PEEBLES AND CO., Ltd., is to build eight 275kV transformers with an aggregate capacity of nearly 1600MVA. Four 240MVA, 275kV/132kV auto-transformers and two 225MVA, 16kV/285kV generator transformers have been ordered by the South of Scotland Electricity Board for the new Scottish super-grid ; the auto-transformers will be installed at Windyhill and Neilston transmission substations ; the generator transformers will be installed at Kincardine "B" power-station. The remaining units are two 90MVA, 275kV/33kV transformers for Ravenscraig substation of the South of Scotland Electricity Board. They will supply the new steel strip mill of Colvilles, Ltd.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., states that a further contract for the supply and installation of overhead equipment for 25kV, 50 cycles, a.c. railway electrification has been awarded to the B.I.C.C. Group by the Indian Railway Board. This job is valued at £1,200,000 and covers some 300 track miles of the Eastern Railway system. The route to be equipped is on the main line from Delhi to Calcutta and lies between Gaya and Moghalsarai. It forms part of the second phase of the Indian Railway Board's electrification programme and is to be ready for use by July, 1961. The equipment will be similar to that at present being installed by the B.I.C.C. Group for the South Eastern Railway, the order for which was announced in December 1958.

Miscellanea

WORLD'S LARGEST TELEVISION STUDIO.—Under this heading on page 983 of our issue of June 10 we published a description of a new television studio at Wembley which had just come into use. We wrote, however, that it was Studio Five of Associated Television, Ltd. That is incorrect. The new Studio Five belongs to Associated-Rediffusion, Ltd. Our apologies are due.

CONTINENTAL AFFAIRS

by Our Continental Editor

Aluminium in Rolling Stock Exhibition

No. I

FROM June 21 until June 26, an international exhibition, "Aluminium in Railway Rolling Stock," was held at Strasbourg by the Centre International de Developpement de l'Aluminium (CIDA)* acting in collaboration with European railway authorities. Coming so soon after the symposium on the same theme which was held in London last month, the exhibition will have been of especial interest to those who had taken part in the earlier event. On the half-mile of disused sidings at the old station at 28, Boulevard du President Wilson, which had been converted into an exhibition ground for the occasion, could be seen examples of rolling stock dating back to the 1930's, together with some of the most recent designs from several European countries.

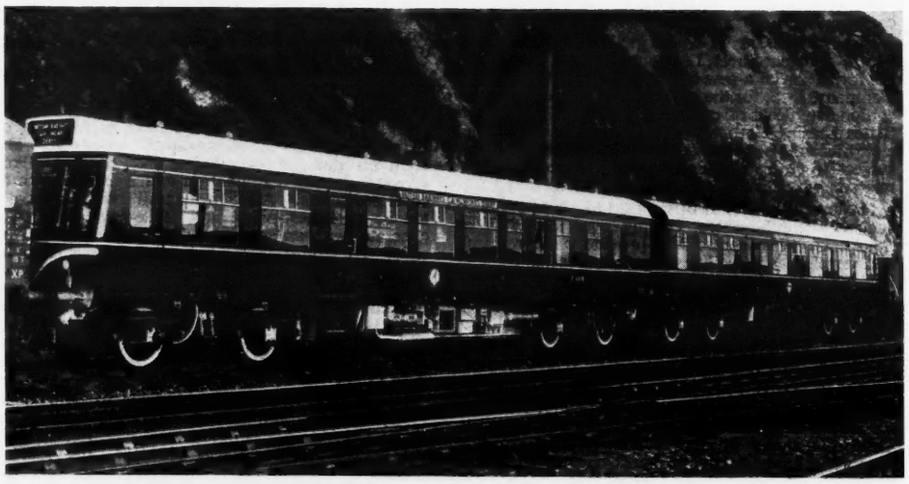


Fig. 1—British Railways' lightweight diesel passenger train-set on its way to the Strasbourg exhibition

Besides some forty-five vehicles, the exhibits included components such as axle boxes, bogie parts, brake equipment, pantographs, windows and doors, as well as such items as fuel tanks for diesel locomotives and a complete cab and section for a diesel locomotive built up from cast panels,

Considering the difficulties involved in withdrawing rolling stock from service for a period totalling more than one week, the organisers must be congratulated upon the excellent selection of examples of aluminium design which they were able to assemble at Strasbourg, and which served well to illustrate the possibilities of light alloy construction in the railway field. Little need be said perhaps concerning the advantageous properties of aluminium and its alloys. The most important in mechanical design is of course their low specific gravity of between 2·6 and 2·8 which, in conjunction with high strength, makes possible a weight saving of 50 to 60 per cent when forged or cast steel is being replaced ; for lightly stressed panels, the same thickness can be used as with steel, giving a saving of 65 per cent, while welded aluminium alloy structures save between 45 and 55 per cent.

Goods and passenger vehicles can therefore be built lighter, reducing traction costs, improving acceleration and braking—this is of interest particularly in the case of suburban services with frequent starting and stopping—increasing the number of vehicles per locomotive and the useful load, and reducing wear and maintenance cost of the permanent way.

While the modulus of elasticity is lower as compared with steel, amounting to about 7000 kg per square millimetre for all the alloys, this can be advantageous as the material is more resilient to impacts. On the other hand, the danger of buckling is greater, and the sections must be increased accordingly.

Aluminium has a high corrosion resistance and therefore need not be painted. Sometimes—as examples in the exhibition showed—the outside of rolling stock has a clear lacquer applied to it for protection. Such a coating can very easily be replaced at small cost. The savings on paintwork alone, it has been stated, more than offset the extra cost of light alloy above that of steel. A decorative effect which was seen on some of the German coachwork consisted of a regular pattern of circular wire-brush marks ; this very effectively broke up the bare metal surface.

In the case of goods vehicles corrosion resistance can be of crucial importance. Aluminium has been used with particular success for tank wagons for such substances as nitric acid, formaldehyde, hydrogen peroxide, milk, and mineral and vegetable oils, &c. High reflectivity to thermal radiation is of importance in helping to protect certain goods from heat or cold.

In recent years, the manufacture of tubes and sections by the extrusion process has come to the fore. The shape of extrusions is practically unlimited, so that very complex sections can be made as easily as simple ones, and thanks to the manufacturers' favourable policy with regard to die costs, special sections can usually be obtained at no extra cost. Many exhibits showed the uses to which special sections can be put, in particular in the construction of passenger coaches.

British exhibits included an example of rolling stock of the Metropolitan line of London Transport Executive of which ninety were built in 1949, and thirteen last year. These cars can hold a total of 160 passengers (seated and standing) and have a tare weight of 28 tons, 5·3 tons less than a steel design and equal to 0·537 tons per foot run, or 1570 lb per seated passenger. The average distance which each car travels in a year is 60,000 miles.

From 1954 onwards, British Railways produced a lightweight diesel passenger train-set consisting of a 29-ton motor car and 21-ton trailer. These vehicles (shown in Fig. 1) are of integral construction, using sheet and extrusions of Al Mg Si Mn. About 4 tons of light alloy is used in the body shell structure of each car. The motor car which seats fifty-two passengers has a weight ratio of 0·558 tons per seat, and weighs 0·5 tons per foot run, while the figures for the trailer (sixty-five seats) are 0·323 tons per seat and 0·36 tons per foot run.

In the field of goods wagons, the British exhibits comprised an 18·35 cubic metre capacity, mineral truck for 16 tons payload, with a tare weight of 6·3 tons of which 500 kg were light alloy for the body. This was argon-arc welded and riveted to the steel underframe using hot-driven steel rivets. About 100 have been built since 1955.

The 21-ton payload capacity, 23·9 cubic metre coal hopper wagon shown was a modification of an all steel design carried out in 1956, of which only one was built for trials. The tare weight, in this case, is 9·85 tons. The wagon has ¼in thick lower sloping hopper plates of Al Mg Si Mn alloy as an experimental replacement. The plates are fitted by means of hot-driven steel rivets.

(To be continued)

* The International Aluminium Development Centre, Paris, was set up in 1950 on the instruction of O.E.E.C. with the aim of facilitating European collaboration in the study of uses of aluminium in the more important industrial fields.

European Course in Sanitary Engineering

In parallel with the International Course in Hydraulic Engineering, which for the last three years has been held by the Technical University of Delft, a European Course in Sanitary Engineering will begin on October 25. This course is being backed by O.E.E.C. and the World Health Organisations in an endeavour to provide advanced training for civil engineers to enable them to deal with problems of water pollution and the supply of drinking water in a highly industrialised region like Europe.

The course, which will be held in English, will extend over two terms, the second of which will end on July 18, 1961. Lectures will include authorities from various European countries and the U.S.A. Among a number of basic subjects there will be lectures on chemistry and microbiology, hygiene, hydrology, statistics, and selected hydraulic topics. The principal fields of study will be domestic and industrial water supply, and the treatment and disposal of liquid and solid wastes, and it will be possible for students to select a combination of subjects. Persons interested in attending the course should hold a degree in civil engineering or a selected branch and preferably should have had at least three years' practical experience. Enquiries should be addressed to: N.U.F.F.I.C., 27, Molenstraat, The Hague, Netherlands.

THE AMERICAN SCENE

by Our American Editor

The "Electra" Accidents

If all goes well, the 136 Lockheed "Electra" turbine-propeller airliners now in restricted use on four continents will soon be arriving at service hangars to undergo alterations that will cost a total of 25,000,000 dollars. The changes are being worked out to eliminate a design defect that is believed to have caused two "Electras" to break up in flight and crash with a loss of ninety-seven lives. The first of the two accidents took place on September 29, 1959, near the town of Buffalo, Texas. A Braniff Airlines "Electra" with thirty-four on board was *en route* from Houston to Dallas when the left wing suddenly snapped off and the four-engine aircraft spun to the ground. The second accident, which took place on March 17 of this year at Tell City, Indiana, involved a Northwest Airlines "Electra" *en route* from Chicago to Miami. The pattern of disaster closely duplicated that of the Texas crash, except that it was the right wing that crumpled instead of the left. All sixty-three on board were killed. In the months since the second disaster, the "Electras" have been flying over their regular routes at sharply curtailed speeds. The speed limit was ordered by the Federal Aviation Agency, and has been observed by the foreign as well as domestic lines. In May, after sixty-five hours of hazardous flight tests and many more hours of wind-tunnel experiments with aircraft models, Lockheed made public its assessment of what had caused the two tragedies. It traced both accidents to violent oscillations that started in an outer engine package and then moved into the wing itself. Because the oscillations occurred at the same frequency, Lockheed said, they fed on one another and, in less than thirty seconds, increased in violence so as to snap off the wing. Several of the numerous design changes being planned will strengthen the engine mounting so that the fatal oscillation sequence can never again be triggered. With these modifications made, the "Electras" will be able to resume their normal operating speeds of about 400 miles an hour. The normal speed of the aircraft at 15,000ft is 397 statute miles an hour, but the current emergency speed limit is 329 m.p.h. This emergency speed limit was ordered to keep the shock of bumpy or turbulent air far below the level at which it could throw a weakened engine mounting into dangerous oscillations.

It is disturbing that an aircraft which had been put through what a highly respected manufacturer considered the most thorough tests possible should prove to be afflicted with so serious a weakness. Lockheed points out that the belated discovery of such hidden defects is the price that must often be paid for advancing the aeronautical art. The firm notes that it is humanly impossible to anticipate every sequence of disaster that could conceivably emerge in a previously unexplored technological area. However, there are other aeronautical experts who argue that painstaking design should reveal inherent weaknesses such as the present oscillation problems. Other aircraft, of course, have also had their share of initial troubles. The Douglas "DC-6," which turned out to be one of the most successful airliners of all time, had to be grounded shortly after its introduction because of a fire hazard that destroyed one plane and almost claimed a second. The Lockheed "Constellation" was grounded for a time after a series of in-flight fires. Although defective engines were suspected, the main trouble was traced to a defective electrical connection between the fuselage and the wing. The Martin "202" had a defective wing that had to be bolstered. The Boeing "Stratocruiser," while never grounded, had chronic trouble with its hollow propeller blades. And the de Havilland "Comet" I airliner had a structural weakness that led to the loss of two aircraft on flights over the Mediterranean. What is clear from the "Electra" investigation, then, is that aeronautical engineers, like their fellow men, are fallible. And what is most reassuring is that, although the complications of aircraft design have been increasing with the advance of technology generally, the fatality rate in commercial operations has been kept reasonably low. This can be attributed to the increasingly intensive testing procedures to which an aircraft is subjected from the day its first components are made. The history of the "Electra" is a good illustration. It was in June, 1955, that the first air-line order was placed for "Electras." American Airlines ordered a fleet of thirty-five. It was not until November, 1957, that the first completed aircraft was rolled off the line, and not until December, 1957, that the first flight was made. In the interim between first sale and first flight, Lockheed went to great length to check the plane's most distinctive new feature—its turbo-prop engine. In pretesting its new "Electra," Lockheed took four of the Allison turbo-prop engines and substituted them for the four regular piston engines on one of its "Constellations." The hybrid plane was test flown for 700 hours under all imaginable conditions. By the time the "Electra" fuselage was ready for its engines, Lockheed knew the engines' every idiosyncrasy. One of the chief concerns was that the fuselage should be strong enough to withstand the great difference between the outside pressure at the high operating altitude and the pressure maintained for passenger comfort and ability to breathe inside the cabin. To prove the cabin integrity, Lockheed built a full-sized fuselage in its laboratory, raised the pressure inside to 2000 lb per square foot, and slashed through it with a remotely controlled axe. The idea was to determine whether a crack developed at altitude would spread catastrophically. The "Electra" fuselage passed the tests in good order.

It was not until air-line operations began early in 1959 that anything really disturbing turned up. And this had more to do with passenger comfort than safety. Vibration on the "Electras" proved far more jarring to passengers than had been anticipated. The trouble was traced to the fact that, under certain conditions, the "Electra" flew at an angle that tilted its engine housings slightly downward. The loads on the propellers kept rising and falling with each revolution because they were not precisely perpendicular to the line of flight. The trouble was cured by tilting the engines and housing upwards by 3 deg. Then came the real trouble—the loss of a wing and disaster at Buffalo. For months, investigators explored one blind alley after another. Because witnesses had seen a ball of fire, the investigators looked for sources of in-flight fire. Someone remembered having heard the co-pilot discuss a technique for dislodging a runaway engine by abrupt upward movement of the controls. Could such a movement have torn off the wing? Not until the Tell City crash did the problem begin to clarify. There was great similarity between the two accidents. In both cases, a wing had come off. The patterns of disintegration were remarkably similar. Most important, a metallurgical study of the wing severed over Tell City produced evidence that it had been bent both up and down. And both aircraft had been flying in clear air, so that the phenomenon of violent motion of seemingly clear air could have affected both. Now began an extensive programme to study the possibility of destructive oscillation. Lockheed engineers strongly suspected that the problem could not have existed on an otherwise sound aircraft, or there would have been many more than two crashes. Some damage must have been incurred by the 'plane beforehand. To test their theories, they initiated two series of tests. First, a sound "Electra" was taken aloft by company test pilots. With its wings, engines and other key parts heavily instrumented, the aircraft was flown through an area over the Sierra Mountains where some of the severest clear-air turbulence is known to prevail. In sixty-five hours of test, the plane survived the severest gusts without any sign of dangerous oscillation. But the instruments did show that the pressures on the engine housings were more severe than had been anticipated. To find out what would happen if the aircraft was not sound, and took off with an undetected weakness, the Lockheed engineers installed a wind tunnel model of wing, engine and engine mount. They rigged the engine package in such a way that they could, on successive "flights," gradually reduce the restraints holding the package in position. When the restraints had been loosened to a certain point, the engineers found what they were looking for: the engine package began a severe oscillation. Further wind-tunnel tests produced the final sequence of disaster, a sequence Lockheed is convinced doomed the two "Electras" that crashed in Texas and Indiana.

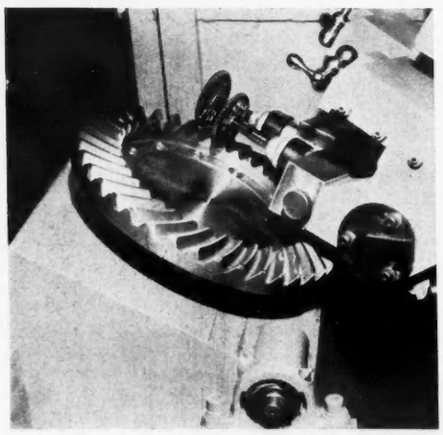
The violent oscillation of the engine package was transferred to the wing, which began to oscillate up and down. At a certain speed, the frequency of the engine-package oscillation coupled with the frequency of the wing oscillation. Lockheed has emphasised

THE AMERICAN SCENE *(Continued)*

that neither the weakened engine mounting nor a severe gust could by itself have destroyed an " Electra." The existence of a weakened section without subsequent turbuence would produce no oscillation. Nor would the most severe gusts disturb an " Electra " if the engine mounting had not previously been damaged. The company points out that the coupling of the engine and the wing oscillations can occur only at one particular speed. The " Electra " fleet is now flying some 50 miles an hour below this speed, by order of the U.S. Federal Aviation Agency. Detailed design changes are currently being proposed by Lockheed to the F.A.A. Once these changes receive official approval, the company will face the difficult problem of negotiating with the air-lines as to who will foot the 25,000,000 dollar bill for modifying the 136 aircraft now in service.

Automatic Grinding Machine for Gear Teeth

A TWIN-SPINDLE automatic high-speed grinder designed to simultaneously deburr and chamfer the entire contour of both ends of the teeth on spur, helical or bevel gears has been developed by the Michigan Tool Company, of Detroit, Michigan. The machine drives reinforced grinding wheels at 17,000 r.p.m. with standard air spindles, which rotate in directions to prevent the wheels from " digging in." The standard machine will handle gears from 3in to 13in o.d.; other models are available for gears up to



Automatic grinding machine for gear teeth, with two grinding wheel spindles following the tooth contour

20in o.d. In operation, it is only necessary to start the wheel spindles, place the gear on the fixture and press the two start buttons to start the machine cycle. The grinding wheels are protected by the head during loading and offer no safety hazard.

After a preset number of rotations of the gear, during which the grinding wheels rise and fall to follow the contour of the heel and toe, the spindles are raised, the fixture is lowered to the unload position and fixture rotation is stopped, all automatically. The number of rotations of the gear is determined by the depth of chamfer desired, or the amount of material to be removed. The cycle time set on the adjustable timer is determined by the number of rotations required, the pitch of the gear and its size, varying from twenty to sixty seconds per gear. The gear rotation speed is selectively adjustable, and the counterweights incorporated in the spindles are adjustable to vary grinding pressure on the work. Depending on gear size, grinding wheel diameters from 1¾in to 3in are used. To equalise wear on both sides of the wheels, they are interchanged on the spindles after about four hours.

Volatile Detonation Inhibitor

IN a paper presented to the Summer Meeting of the Society of Automotive Engineers (June 5–10) in Chicago three members of the Research Department of Socony Mobil Oil Company described their discovery of certain special properties of Tetramethyl Lead (" TML "), a new additive for the improvement of the anti-knock qualities of modern petrols. The value of the new additive (first announced in January), which boosts the octane number of the lighter components of petrol, was discovered following extensive work in the company's Paulsboro, New Jersey, Research Laboratories, and road tests carried out on many makes of cars by Mobil affiliates in England, America, France, Germany and Italy. The research effort was prompted, in the first place, by a stubborn knock in the cylinders of certain cars using some of to-day's gasolines.

" TML " is deemed to be a very important addition to methods available to refiners for production of high road octane number petrols. The authors predicted that within five years it will be widely used by refiners—to overcome the problem of octane depreciation of petrols produced by the most modern refining techniques, when used in modern manual transmission cars, and to increase the anti-knock quality of levels of petrols still further.

In their paper, the authors, R. H. Perry, Jnr., C. J. DiPerna and D. J. Heath, explained that refinery methods have changed during the past ten years, the proportion of petrol produced by catalytic cracking and catalytic reforming techniques having increased at the expense of that produced by straight-run and thermal techniques. The platinum catalyst reforming technique is the most significant recent development. Widespread use of this process has made possible most of the increase in motor gasoline octane numbers which has occurred in the past ten years. However, efficient usage of the very high quality gasoline components produced by this process has presented the one formidable problem referred to above, i.e. road octane depreciation. In some cars, especially those with manual transmissions, gasolines containing large percentages of catalytic reformate were found to have much lower road octane numbers than were predicted from the research and motor method ratings. A combination of two factors was found to be responsible.

(1) Uneven anti-knock quality distribution over the whole boiling range of catalytically-reformed petrol—a significant portion of the petrol was much lower in anti-knock quality than the petrol overall. That portion of the petrol boiling at about 200 deg. Fah. was sometimes twenty octane numbers lower in anti-knock quality than the heavier and lighter fractions.

(2) Uneven mixture distribution to the individual cylinders through the intake manifold system. During the initial portion of an acceleration from a low engine speed there is a separation of light and heavy components in the manifold and all cylinders do not receive the same mixture. If the anti-knock quality distribution of the petrol is uneven then some cylinders receive a mixture with a lower anti-knock quality than that of the petrol overall. This condition is further complicated by the fact that " TEL," because of its high boiling point (392 deg. Fah.), is concentrated in the less volatile petrol components.

Socony Mobil Oil Company found that road octane number depreciation in manual transmission cars could be related to the following factor : (Vol. fraction of IBP—220 deg. Fah. Cut) × (Research Octane Number of Petrol) minus (Research Octane Number of IBP—220 deg. Fah. Cut at one-third " TEL " Content of the Petrol).

From the form of the above " depreciation factor " it is evident that depreciation could be reduced by :

(1) Increasing the research octane number of the lower boiling fractions, or

(2) reducing the fraction of the petrol boiling below 220 deg. Fah. Large changes cannot be effected in the latter because this would markedly affect other performance characteristics, such as warm-up, and so, after considering many ways, including the changing of refinery processing plans, it was decided that alternative (1) should be followed by increasing the anti-knock additive concentration in the fractions with a boiling point up to 220 deg. Fah.

In all tests carried out with " TML," " TEL " and many intermediate lead alkyls, " TML " was by far the most effective in reducing the road octane number depreciation of reformate petrols. The effectiveness of the other ethyl methyl lead alkyls generally decreased in order of increasing boiling point, " TEL " being least effective. " TML " was most effective because it has the lowest boiling point and, in the induction manifold, is distributed with the lower octane fractions of the petrol.

Iron pentacarbonyl was also very effective, but was ruled out because of its adverse effects on engine wear.

In the course of the work, another very important discovery was made with regard to tetramethyl lead usage—not only was " TML " more effective than " TEL " as measured by road ratings of reformate fuels in manual transmission cars, but it also was a more effective anti-knock additive than " TEL " as measured by Motor and Research Method ratings. Furthermore, the advantage for " TML " was found to increase as the anti-knock quality of the catalytic reformate increased.

Thus, " TML " represents a very important addition to methods available to refiners for the production of high road octane number petrols. It not only possesses an advantage over " TEL " for increasing research and motor octane numbers in catalytic reformate blends, but it also enables refiners to overcome the problem of road octane depreciation peculiar to the petrols refined by catalytic reforming techniques, and so opens the way to the wider use of these latest and more advanced techniques.

Potable Water Supply in Sealed Vehicles

RESEARCH for a solution of the water supply problem for man on an extended space trip is now underway at General Electric's Space Sciences Laboratory ; the work is being done under a 94,000 dollar contract recently awarded by the National Aeronautics and Space Administration to the Company's Missile and Space Vehicle Department.

Using a unique vacuum pyrolytic catalysis technique, the approach involves vaporising the volatiles in the biological wastes at reduced pressures and hence low temperatures. The vapour is then pyrolysed over a catalyst and thence condensed back to a liquid state. This condensate has been analysed and found to be without odour, colour or toxic materials and suitable for human consumption, according to General Electric scientists. The technique does not require chemical additives or filtering.

Rats and a monkey will be used in the study to determine if the feeding of recycled recovered water has any effect on animals. The rats will be studied through more than one generation, while the monkey will be carefully observed during a prolonged confinement in a closed area. Besides visual observation, periodic tests of waste samples will be made to determine the animal's health. If indicated, the monkey will be removed for more thorough physical examination. The monkey will be provided with a three-day supply of water in the semiclosed system. Dry food and dry air will be added as required. (In a closed system nothing is added or subtracted.) Waste products, including moisture from the vented air, will be collected, processed, and returned to the system.

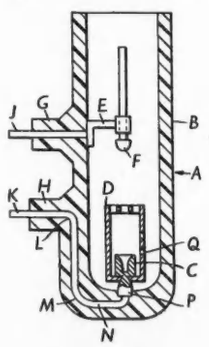
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

ELECTRICAL ENGINEERING

837,004. July 27, 1956.—HIGH-VOLTAGE ELECTRIC CIRCUIT-BREAKERS, A. Reyrolle and Co., Ltd., Hebburn, County Durham. (*Inventor: John Christie.*)

This invention comprises an improvement in or modification of the present applicant's British patent specification No. 756,074, which claims a high-voltage electric circuit-breaker in which the arc is drawn in a tank comprising an insulating moulding containing arc-extinguishing fluid, the tank moulding being electrically stressed in service and being made of cast resin. It concerns the location of the conductor leading to the fixed contact, which extends past the arc-control device substantially from end to end to form a current loop and is embedded in the moulded wall of the tank between its outer and inner surfaces. In the embodiment illustrated an oil circuit-breaker *A* is provided with a moulded insulating tank *B* of cast resin in which are mounted a fixed lower contact *C* in a vented arc-control device *D* and a moving contact guide *E* in which slides the moving upper contact *F*. The moulded tank is formed with a pair of integral plug-type bushings *G* and *H* which are respectively



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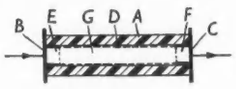
associated with and insulate the two high-voltage conductors *J* and *K*. The lower conductor *K* extends horizontally into the lower bushing *H* in which it is embedded, but instead of projecting horizontally through the wall into the interior of the tank it is bent downwards through a right angle at *L* and then extends vertically down within the vertical side wall in which it is embedded. At the bottom of the tank the conductor is curved at *M* to follow the curve of the tank and extends horizontally at *N* within the bottom wall of the tank in which it is embedded, until it reaches the centre of the tank bottom where the conductor terminates in an upwardly projecting portion *P* which emerges into the interior of the tank for connection to the fixed contact at the bottom of the arc-control device. The embedded portion of the conductor thus extends past substantially the whole of the arc-control device from end to end in a direction generally parallel to its axis, and then curves round beneath the arc-control device to join the fixed contact. The embedded portion thus constitutes a fairly tight current loop producing a magnetic field which will tend to drive the arc laterally towards the vents *Q* of the arc-control device, the latter being arranged with its vents on the opposite side of its axis to the side facing the embedded portion of the conductor. Thus the lower conductor is buried within the solid insulating material of the tank and does not emerge into the interior except at its extreme tip. The possiblility of flashover during circuit-breaking within the tank between the movable contact and the lower conductor connected to the fixed contact is consequently reduced, owing to the resistance to electrical puncture of the solid insulation covering the conductor.—*June* 9, 1960.

837,278. June 9, 1955.—VARIABLE RESISTANCE DEVICES, Siemens-Schuckertwerke Aktiengesellschaft, Berlin and Erlangen, Germany.

According to this present invention a variable resistance device comprises a carrier having at least one electrically conductive solid coating formed on and in intimate contact with its surface and means for varying the overall amount and/or the chemical composition of the material constituting the coating so as to vary the number of charge carriers and hence the electrical resistance per unit length. Various resistance devices based on this principle are illustrated in the specification. In the example reproduced herewith an insulating tube *A*, made of, for example, glass, is sealed by metal discs *B* and *C* fused to the two ends. A metal coating *D*, for example of zinc, is initially situated on the inner surface of the glass tube. At *E* and *F* are leads in the form of metal coatings which can be evaporated only with difficulty, for example of platinum. It will be assumed that the internal space *G* has been exhausted. When a



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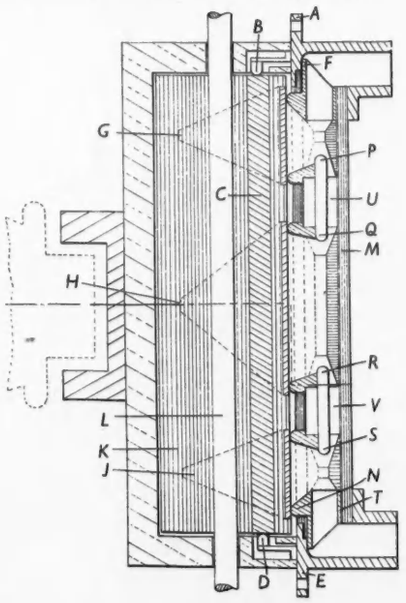
current flows in the direction of the arrow from the disc *B* through the coating *D* to the disc *C*, heating of the coating results if the current strength is sufficiently great, and, in accordance with the momentary associated vapour pressure, a part of the coating will be converted into vapour and will thus be ineffective for current conduction. However, this in turn has the result that the cross-section of the coating is reduced and the resistance is correspondingly increased. Assuming that the coating was 0.1mm thick at the commencement, then when a thickness of 0.001mm is reached, the resistance will have risen to 100 times the original value. However, this high value is by no means a boundary value, since a monomolecular coating has a thickness of only about 10^{-7}mm and still exhibits clear metallic conductivity. Therefore, with such an arrangement a resistance change by many orders of magnitude can be produced. Coatings *E* and *F*, which are difficult to evaporate, prevent excessive cooling by discs *B* and *C* so that temperature distribution over coating *D* is as uniform as possible. With a sufficiently large energy supply, a resistance change through at least two orders of magnitude can be produced after milli-seconds or even fractions of a millisecond. Since the heat of fusion and evaporation of the coating may also be utilised, it is possible to dissipate, for example, energies of up to 15kW and more per cubic centimetre of coating material. When the current is interrupted, the system cools and the metal vapour condenses on the inner wall of the tube *A*, whereby the original state is restored.—*June* 9, 1960.

FLUID BLAST ELECTRIC SWITCHES

836,750. July 19, 1957.—FLUID BLAST ELECTRIC SWITCHES, Emil Lange, 65, rue de Versailles, Vill d'Avray, Seine et Oise, France.

In a fluid blast switch the rapid production of the pressure and full use of the fluid medium are of the greatest importance for reliable operation in quenching the arc. In order to quench the arc within the period of one current alternation a powerful pressure wave or a very rapid pressure rise is necessary, and it



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is also necessary to utilise the avilable quenching medium as fully as possible for the quenching operation, since due to the necessarily small volume of the quenching chamber only a small amount of medium is available. According to this invention there is provided an electric fluid blast switch in which the arc is quenched by a blast of quenching medium under pressure produced by the arc itself. When the switch is in the closed position as shown in the drawing, the current flows directly through the terminal *A* pressure contact *B*, current bar *C*, pressure contact *D* and the second terminal *E*. At the same time, the current flows indirectly also through the terminal, the contact *E*, and bridge contracts *G*, *H* and *J* to terminal *E*. During opening of the switch the roll or drum *K* is rotated by means of the shaft *L*, and the bar *C* is moved away from the contacts *B*, *D*, without forming an arc, so that now the current flows only through the contacts in the quenching chamber *M* and the bridge-contacts. During further rotation of the drum, the wide parts of the triangular bridge-contacts at first still slide on the intermediate contacts, one of which is seen at *N*. Due to the triangular shape of the bridge contacts, upon further rotation of the roll they leave the intermediate contacts and six arcs are formed. These six arcs are rapidly drawn out in length and conducted towards the middles of the three open interruption gaps, so that they join up and burn as three arcs in the quenching chamber between the contacts *F-P*, *Q-R* and *S-T*, the arc between *Q-R* being the pressure-producing arc. Due to the very rapid extension of the three arcs in the interior of the quenching chamber, a rapid and great pressure rise is produced and the roots of the arcs at the contact tips *P*, *S* and *Q*, *R* are immediately exposed to effective blasts of quenching medium, and the quenching of the arcs takes place readily and reliably. The spaces *U*, *V* are of particular importance for the quenching operation, since there some of the available amount of quenching medium is not prewarmed by the arcs and thus cold quenching medium flows over the contact tips *P*, *S* and effectively influences the arc quenching.—*June* 9, 1960.

FURNACES

836,731. March 26, 1956.—SHAFT FURNACES, British Iron and Steel Research Association, 11, Park Lane, London. W.1. (*Inventor: William Anderson Archibald.*)

This invention relates to shaft furnaces, including blast-furnaces, cupolas and shaft kilns, which in operation contain a charge of closely packed, mainly solid granules of burden flowing through the furnace either continuously or intermittently. To improve the period of operation of such a furnace it was proposed in a previous specification, No. 299,941, to replace the lining as it becomes worn by agglomerated burden or to build up a lining of agglomerated burden. For this purpose, hollow water-cooled blocks inserted in the lining and spaced apart round the furnace in rings cause burden to agglomerate and to replace the initial lining as it is destroyed. In accordance with the present invention, a shaft furnace of the type described has, on the interior, rings of heat-resistant shelving, spaced at such a distance that the burden layer extends from each ring to the one above, the shelving having sufficient mechanical strength to support that layer alone. If any part of the lining of the burden is lost by erosion or a temporary change in the conditions within the furnace, such as increased temperature or intensity of oxidising conditions, it is immediately replaced by further burden from the charge so that stoppages due to failure of the lining are obviated. The shelving illustrated in this specification is intended to support a trapped layer of burden without causing it necessarily to become agglomerate. The furnace may be constituted by a cooled metal shell from which the baffles project. In use, the permeability of the lining of trapped burden is low due to dust and small particles, and accordingly the rate of loss of heat by penetration to the shell is small. The low heat transference has the further effect of keeping the face of the lining in contact with the wall at a low temperature with the result that there is no keying or fusion of the lining material to the wall. Owing to the outward pressure of the burden on the lining, scaffolds forming on the lining may not be removed automatically during operation of the furnace. The scaffolds may, however, be removed by raising the temperature of the furnace in the region of formation and burning off accretions as they form or periodically by introducing oxygen or air through the furnace wall.—*May* 25, 1960.

METALLURGY

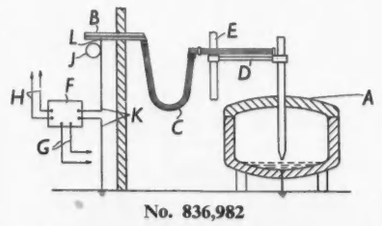
836,026. August 15, 1957.—MARTENSITIC STAINLESS STEELS, John Ivan Morley, 175, Hemsworth Road, Norton, Sheffield 8, Yorkshire, Charles Sykes, F.R.S., Atlas and Norfolk Works, Sheffield 1, Yorkshire, and Robert Mowbray Norris Gray, 10, Whirlow Park Road, Sheffield 11, Yorkshire.

In its broadest aspect, the present invention provides highly corrosion-resistant martensitic steel which is an improvement in or modification of the composition according to Patent Specification No. 813,801. It comprises: 0·03 to 0·12 per cent carbon plus nitrogen (with total nitrogen not exceeding 0·03 per cent), over 13·5 and up to 17·5 per cent chromium, 4·0 to 6·0 per cent nickel, 0·5 to 2·5 per cent copper, 0·3 to 3·0 per cent molybdenum, 0·5 to 2·5 per cent manganese, 1 per cent maximum silicon, and 0 to 0·2 per cent, preferably at least 0·03 per cent, of any one or more of the following carbide and nitride forming elements, titanium, vanadium, and niobium, and the remainder iron except for any aluminium introduced as an impurity in the ferro alloys, small residual amounts of elements, such as sulphur and phosphorus associated with steel melting processes. Steels according to the invention may be produced as castings, or as forgings, stampings, plates or bar by hot-rolling, or as cold-rolled sheet, strip, foil or cold-drawn wire, and may be heat-treated to a high-tensile strength in a similar manner to that described in the previous application. A preferred composition embodying the invention contains carbon not more than 0·06 per cent, chromium 15 to 17 per cent, nickel 5 to 6 per cent, copper 1 to 2·5 per cent, molybdenum 1·5 to 2·5 per cent and titanium 0·03 to 0·12 per cent. The invention enables steels to be provided capable of being fully heat-treated to develop mechanical properties and corrosion resistance similar to those according to the earlier application and which by virtue of the modified composition are capable of developing more consistently a soft low yield point condition as the result of an intermediate heat-treatment. This property is advantageous in the production of sheet, strip, foil and wire rod or coil by the customary methods of cold rolling or cold drawing. Furthermore, it enables stainless steels to be supplied as sheet, strip, foil or wire in a soft condition so as to facilitate severe forming into different components. —*June* 1, 1960.

ELECTRIC FURNACES

836,982. January 12, 1955.—ELECTRIC FURNACES, Birlec, Ltd., Birlec Works, Tyburn Road, Erdington, Birmingham 24. (*Inventors: Edward May and William Leonard Harrison.*)

This invention has reference to electric furnaces of the kind comprising one or more charge-heating electrodes to which electric current is supplied from a transformer or equivalent source, and automatic control gear for adjusting the electrode or electrodes relatively to the charge and one another. In all cases, the impedance presented to the electrode current tends to vary during normal operation of the furnace and it is usual to arrange for the control gear to displace the electrode or electrodes relatively to the charge and to one another in an attempt to compensate for any such variation and thereby keep the arc voltage and current within preselected limited values. However, whilst it is relatively easy to create control signals which are proportional to the arc current (for example, by use of a transformer in the electrode circuit), difficulties arise in creating control signals which are proportional to the arc voltage. The principal object of this present invention, therefore, is to enable a



No. 836,982

voltage-signal lead to the electrode control gear, to be connected in the electrode circuit at any convenient position (for example, at or near the furnace transformer or equivalent source of current supply) and yet feed to the gear voltage signals which are accurate measures of the true arc voltage under all conditions of load. The accompanying diagram shows one electrode of an a.c. arc furnace. Current is adapted to be supplied to the electrode *A* from a transformer (not shown) through busbar *B*, and flexible cable *C*, as is known. The electrode is supported by an arm *D* which is mounted upon and is displaceable along a vertical mast *E* by a winch adapted to be driven by a motor actuated by a control gear *F* through leads *G*, and the secondary of a current transformer of which the primary is adapted to be energised by the current in the busbar *B* is connected to the control gear through leads *H* for supplying to the gear signals proportional to the arc current so that the gear is adapted to actuate the winch in a manner which adjusts the electrode to compensate for variations in the said arc current. A coil or winding *J* is connected in series with an earthed voltage-signal lead *K* between a voltage-measuring connection *L* in the busbar and the control gear. The coil is so wound and located relative to the busbar, and its connections in the lead *K* are of such polarity that, when the furnace is in operation, there is induced in the coil a voltage proportional to the current flowing through the busbar and in opposition to the inductive voltage drop in the electrode circuit between the connection *L* and the tip of the electrode. Although the drawing shows only one electrode and associated control gear, the furnace will generally include three electrodes and a separate control gear will be associated with each.—*June* 9, 1960.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

INDUSTRIAL PROTECTIVE GLOVES

No. 1651 : 1960. Price 10s. The seventeen types of glove specified in this revised publication offer protection against the majority of industrial hazards to which the hands are vulnerable. Shot-blasting, welding, furnace work, riveting—these are some of the operations in which the wearing of gloves to B.S. 1651 will protect the operator (the standard contains an extensive list of classified hazards). Materials for the gloves fall into four groups : leather, plastics, rubber and cotton. "Experiments," states the Foreword, "are being carried out with new materials for gloves and glove linings made from man-made fabrics and mixtures of man-made fibre and cotton. Depending on the outcome of these experiments, an amendment to the standard may be issued later." Of the seventeen types of glove specified in the 1950 edition, one has been discarded. It has been replaced by fabric-lined rubber gloves and gauntlets. The forty-six page publication specifies design particulars, size, and detailed dimensions. Also specified are requirements for materials, and for their testing. In one test, air at a pressure of 20 lb per square inch is introduced into the glove ; no air bubbles must be seen to escape when it is immersed in water. The construction of the protective gloves is fully dealt with, illustrations being used to amplify the text where necessary, particularly as regards the different types of glove.

TEST METHODS FOR BITUMEN

No. 3235 : 1960. Price 8s. 6d. This new publication contains eleven authoritative general methods of testing bitumen suitable for the specification of bitumen-containing compositions used in the building, road engineering and electrical industries. The issue of B.S. 3225 sees the collection in one volume of most of the test methods applicable to the various bitumen-using industries. The exceptions are special methods for particular types of composition : these are described in the standards themselves (e.g. B.S. 434, 598 and 1858). Thus all the information needed for the specification of bitumen-containing compositions used in these industries is available in British Standard publications. The methods, which are technically identical with the corresponding methods of the Institute of Petroleum, are for the determination of : (1) Ash ; (2) Ductility ; (3) Flash point (open) and fire point, using Cleveland apparatus ; (4) Flash point (open) and fire point using Pensky-Martens apparatus ; (5) Fluxing value of flux oil ; (6) Loss on heating bitumen and flux oil ; (7) Penetration ; (8) Softening point (ring and ball) ; (9) Solubility in carbon disulphide ; (10) Viscosity of cutback bitumen and road oil ; (11) Water content (Dean and Stark method).

RUBBER GLOVES FOR ELECTRICAL PURPOSES

No. 697 : 1960. Price 5s. This revised publication (seventeen pages) specifies requirements for gloves for use at four different voltage potentials : up to 650V, 1100V, 3300V, and 4000V. The gloves may be made by a dipping process or built-up from sheet rubber, or by a moulding process. A feature of the revision is that each glove is now required to be tested twice by the manufacturer for its voltage withstand. The second test has been introduced to seek out those gloves which have a tendency to pick up excess moisture, which reduces dielectric strength. Research work into this phenomenon has been carried out by the Electrical Research Association, who have taken an active part in the re-drafting of the standard. An appendix to the standard contains a series of helpful notes relating to the maintenance of the gloves after purchase. B.S.I.'s Kitemark monogram may be applied to the gloves if the manufacturer is licensed to use it.

BOURDON TUBE PRESSURE AND VACUUM GAUGES

No. 1780 : 1960. Price 15s. Prepared by a committee of experts, this new publication specifies requirements for indicating pressure gauges, vacuum gauges and combined pressure and vacuum gauges of the bourdon tube type. The range of nominal sizes is 2in–12in ; and the maximum scale readings are up to 16,000 lb per square inch or up to 6 tons per square inch. Requirements are specified for test gauges with concentric scales and for industrial gauges with concentric and eccentric scales. The standard gives a range of sizes for direct mounting and surface mounting gauges ; and a series of standard pressure ranges and scale graduations. Among the seven sections of the volume are those dealing with : materials and construction ; dimensions ; accuracy ; testing and inspection ; marking and packaging. Buyers and suppliers will find a list of eighteen items of information which should be embodied in an order. The new standard concludes with nine appendices. Typical titles are "Notes on testing apparatus and methods," and "Recommendations on the installation and use of gauges."

Code of Practice

TRAFFIC BEARING STRUCTURES—PAVINGS

Code 2006 : 1960. Price 30s. This latest addition to the range of civil engineering codes of practice is published by the British Standards Institution and was prepared by a committee convened by the Institution of Civil Engineers on behalf of the Council for Codes of Practice. A wide range of theory and practice has been covered. Perhaps the greatest problem encountered by its compilers was to keep abreast of a rapidly changing technique in paving work—arising principally from increasing use of highly mechanised methods. The Code represents a guide to good practice and takes the form of recommendations ; it is not a specification.

Code 2006 is divided into five parts which cover respectively : design and construction of foundations; concrete roads and airfields ; surfacings other than concrete ; footways, cycle tracks and verges ; and surface water drainage. It includes a comprehensive series of tables and figures referring to numerous practical aspects of paving design and construction. A considerable array of principles and factors governing both the estimation of pavement thicknesses, and the construction of foundations from widely differing materials—and under very different physical or geological conditions—is included. The design and construction (including quality control) of concrete pavements is dealt with in an exhaustive but essentially practical fashion.

The remaining three parts (dealing with surfacings other than concrete ; footways, cycle tracks and verges ; surface water drainage) are concerned rather more with the descriptive than the analytical.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Wed., July 6.—MANCHESTER BRANCH : The Engineers' Club, Albert Square, Manchester, 2, Films Evening, 7.15 p.m. ★ NORTH LONDON BRANCH : Wood Green Civic Centre, Town Hall, Wood Green, "The Work of the N.I.C.E.I.C," H. C. Breeze, 8 p.m. ★ PRESTON BRANCH : R.A.F.A. Club, East View, Preston, "Connectors and Crimped Joints," 7.30 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Wed., July 20.—Connaught Rooms, London, W.C.2, One-day conference on "A Practical Guide for Management Decisions," 9.45 p.m.

INSTITUTE OF METALS

Mon., July 25.—Royal Institution, Albemarle Street, London, W.1, "The Structure of Metals and Intermetallic Compounds," Linus Pauling, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Thurs. to Wed., July 21 *to* 27.—ELECTRONICS AND COMMUNICATIONS SECTION : Olympia, London, W.14, Third International Conference on Medical Electronics, in association with the International Federation for Medical Electronics.

PLASTICS INSTITUTE

Tues., July 19.—British Plastics Federation, 47-48, Piccadilly, London, W.1, Annual General Meeting, 2.15 p.m.

STANDARDS ENGINEERS SOCIETY

Tues., July 12.—UNITED KINGDOM SECTION : British Standards House, 2, Park Street, London, W.1, Annual General Meeting and Technical Meeting, 3.30 p.m.

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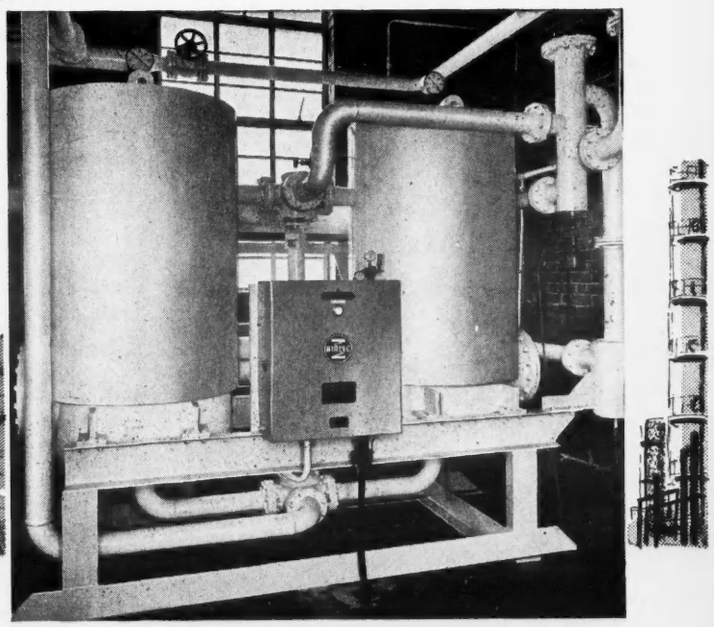

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Shell research chemists have been working on this problem, which has been causing some concern to Management. After considerable research, Shell Dromus Oils have been reformulated and these new cutting oils now produce bland emulsions, which considerably reduce the risk of skin trouble to operators.

The real difficulty was to find a new coupling agent to replace the phenolic compounds, and Shell finally used what their chemists know as a higher fatty alcohol complex. This solved one problem, but presented another. The new coupling agent was volatile at the high temperatures normally used in blending processes. Further research found a solution to this problem by designing and installing new plant. The new Dromus Oils are every bit as efficient as before and cost no more. They put Management in the welcome position of being able to minimise working hazards at no extra cost. And machine men need no longer be so worried about skin troubles.

The moral of the story is that Shell research is supremely applicational. The centre at Thornton is always ready to work with even the most specialised sectors of industry to produce the right oil for the job. If you and your organisation have any major lubricating problems, it pays to get in touch with your local supplier of Shell Industrial Lubricants.

The Research Story

Shell chemists in the U.K., in Holland and in the U.S.A., prepared and examined hundreds of experimental soluble oils, and established that certain combinations of fatty alcohols could be used in place of phenolic compounds with no loss of efficiency. They set to work to discover the best combination and developed a higher fatty alcohol complex which fitted exactly. Then they realised that to blend this new coupling agent into soluble oils would require special plant and new blending techniques.

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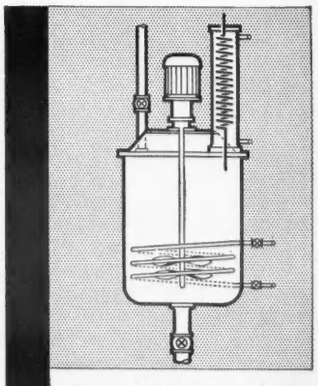

This is the blending kettle. The reflux condenser beside the stirrer motor prevents the loss of constituents volatile at the blending temperature.

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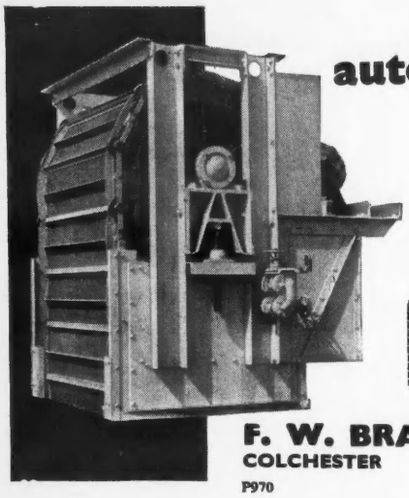

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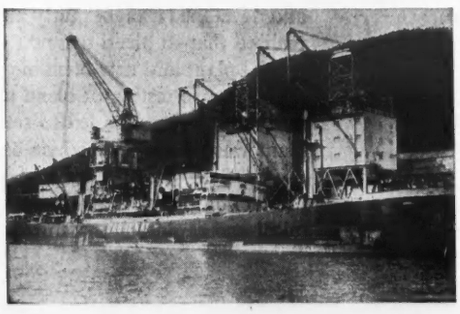

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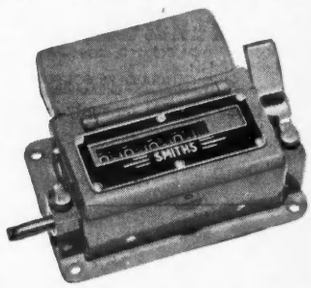

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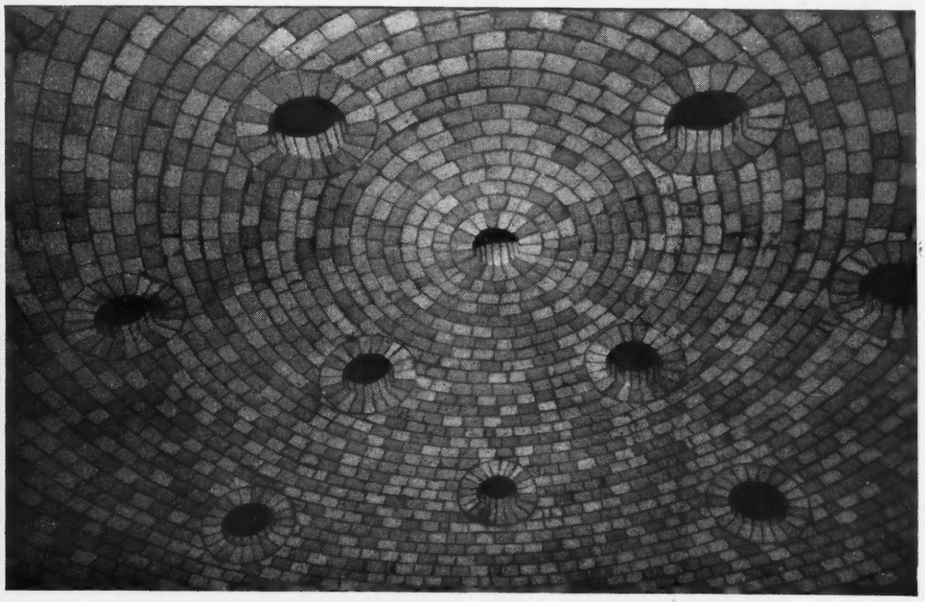

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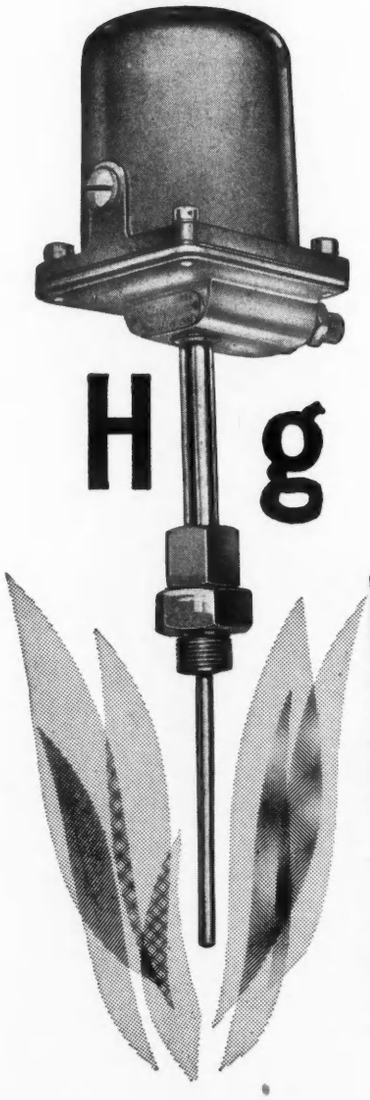

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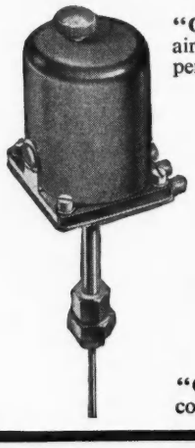

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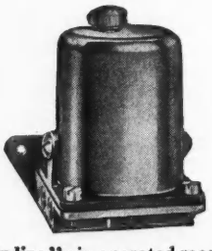

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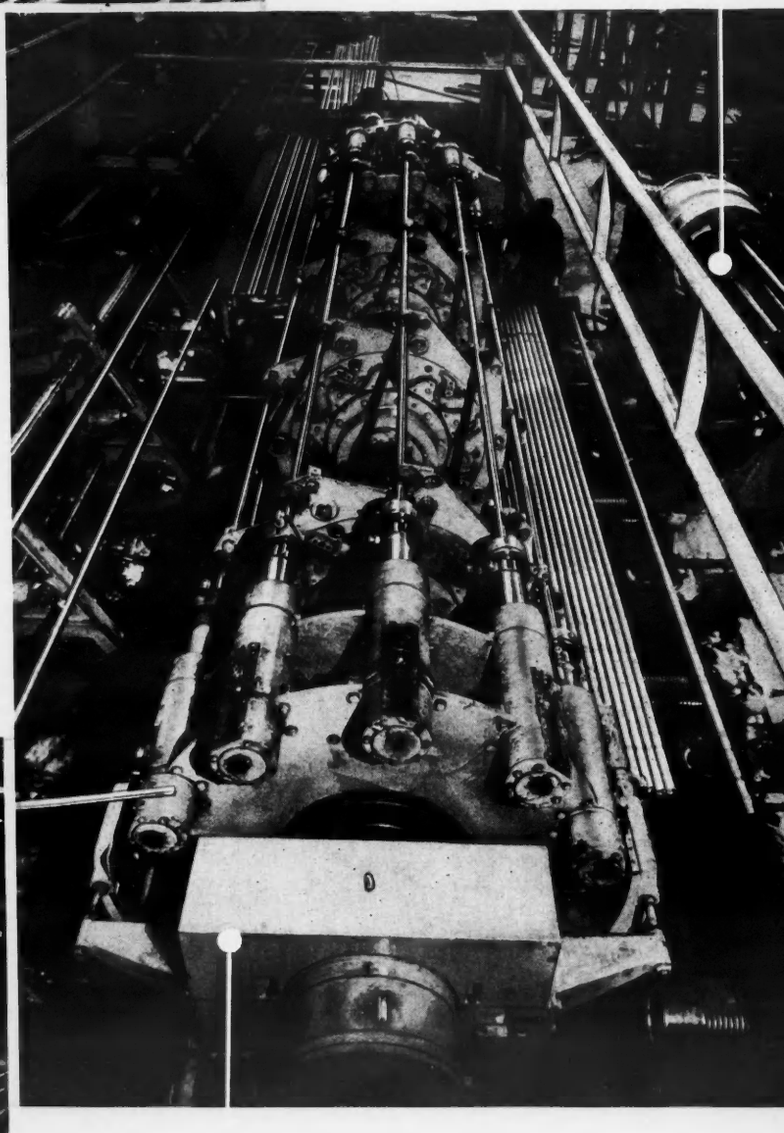

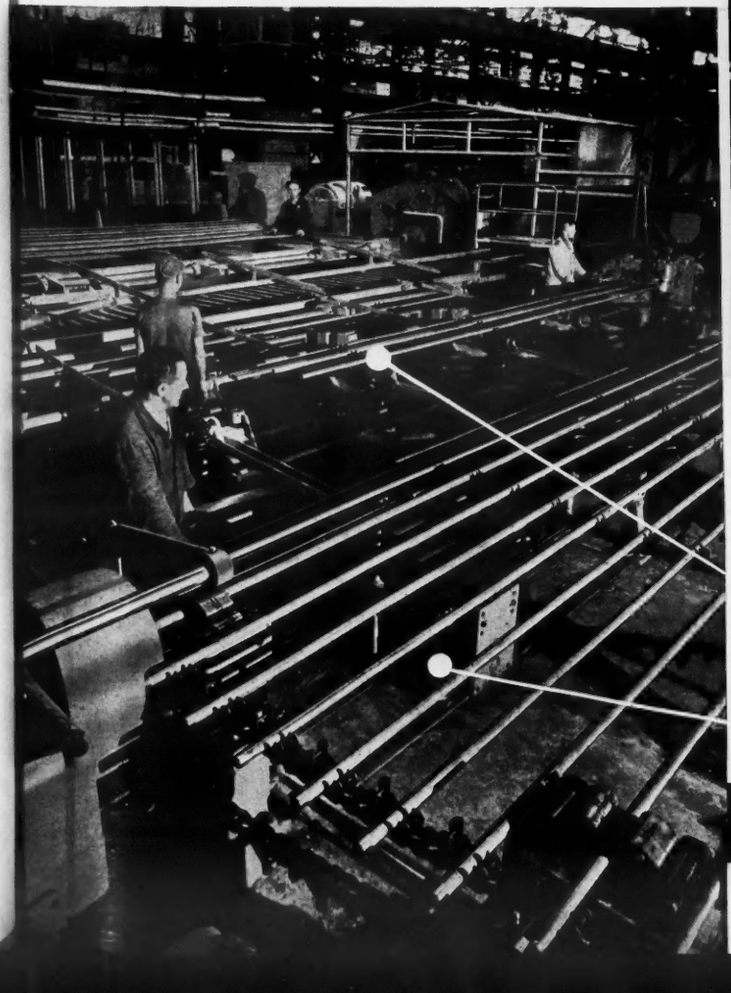

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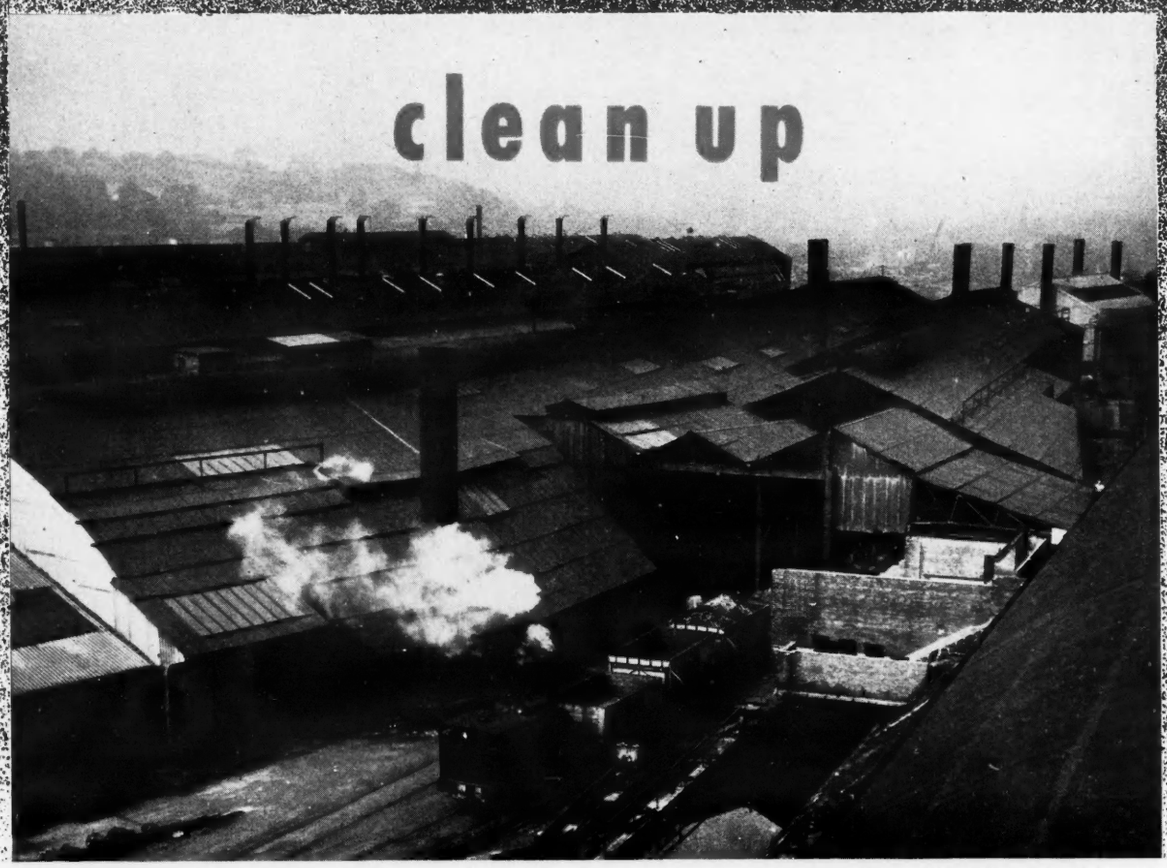

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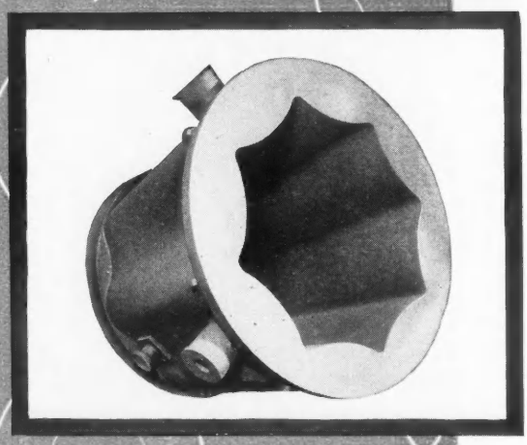

DISTINGTON

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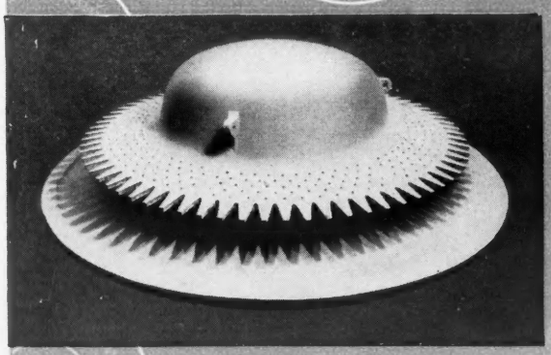
CASTINGS



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COMPANY LIMITED
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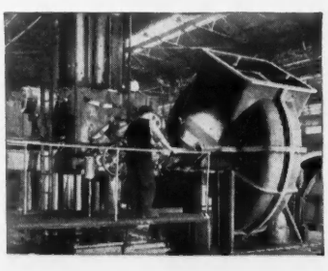

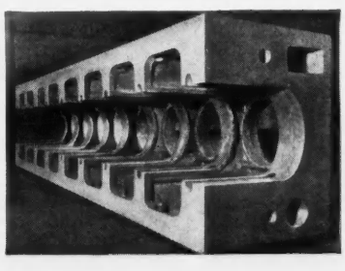

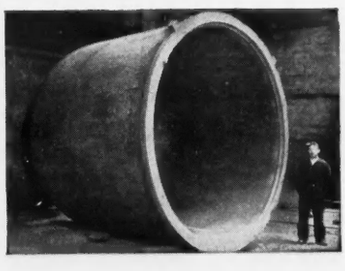

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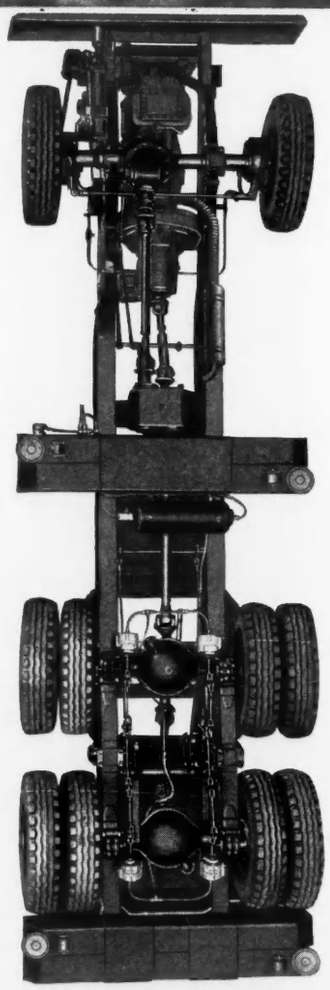
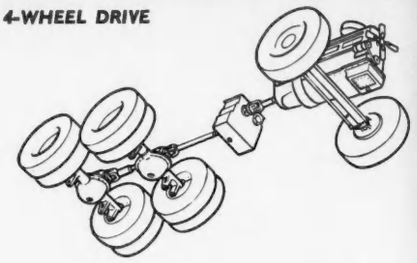
COLES TRUCK CRANES

IMPRESSION

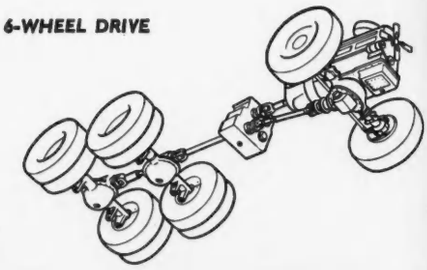
Coles Crane Carriers Are *Specially Designed* And Built For Rigorous Crane Duties .....



4-WHEEL DRIVE



6-WHEEL DRIVE



SPECIALLY DESIGNED CARRIERS

The above illustrations show four- and six-wheel drive models designed to match differing travel and ground conditions.

A TYPICAL 6-WHEEL DRIVE CHASSIS

Coles carriers are engineered as perfect units for crane service. They are not merely standard vehicles converted for crane duties but specially designed chassis built to withstand the heavy stresses and shock loadings peculiar to crane duties.

Coles range of truck mounted cranes is the largest in Europe with lifting capacities up to 50 tons. Each unit is designed and built for top performance in its class and is the outcome of 80 years experience in the field of mechanical handling.

Every Coles component is thoroughly tested for suitability to its task and each carrier is specially designed to withstand the rigours of crane duty. Reliability, pin-point-precision with speed, fast travel from site to site, built-in safety devices and low operational costs—*plus* diesel-electric transmission are some of the profit-making features which have won for these cranes a leading place in world markets. **SEND FOR DETAILS NOW!**

BRAKING POWER

Power operated air brakes act on all wheels to provide gradual and sensitive braking under normal conditions and maximum safety in emergencies. In addition, a mechanical parking brake acts on the rear wheels.

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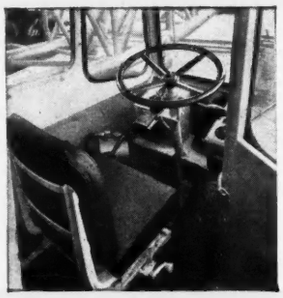
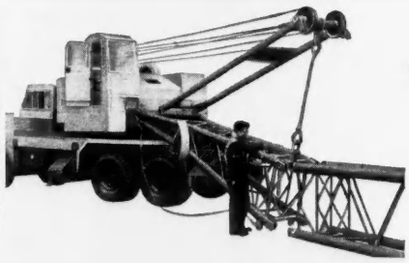
Specially designed rocking beams centrally pivoted to the chassis frame plus generous tyre equipment provide optimum flotation and maximum tractive effort for arduous, off-the-road work.



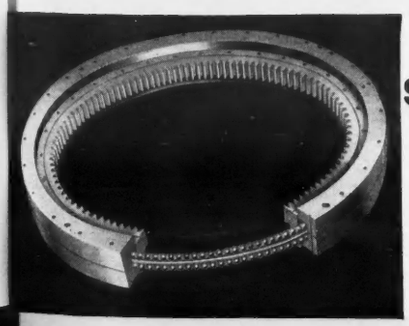
DRIVER'S CAB

Designed for maximum comfort and efficiency Coles chassis cab is equipped with simple, finger-tip controls, large, wide vision windows and fully adjustable seat. To suit climate cab-heating equipment can be fitted or fan and demister.



SELF ERECTING JIB

Coles self erecting jibs mean minimum idle time and consist of a gantry mast pivoted on the lower jib section and reeved into the derricking system. Jibs are pin-jointed to facilitate speedier length conversions.



SLEW BEARING RING

Each Coles revolves on a large diameter double live ring of steel balls running in hardened races. This double race ball bearing obviates the need for a centre-post and gives more even distribution of loading on the chassis frame.

Coles **RANGER**

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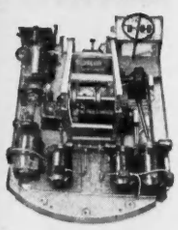
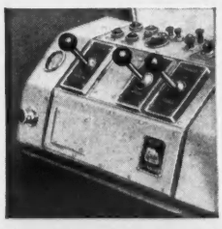
ESEL-ELECTRIC TRANSMISSION - *A power for good in handling*

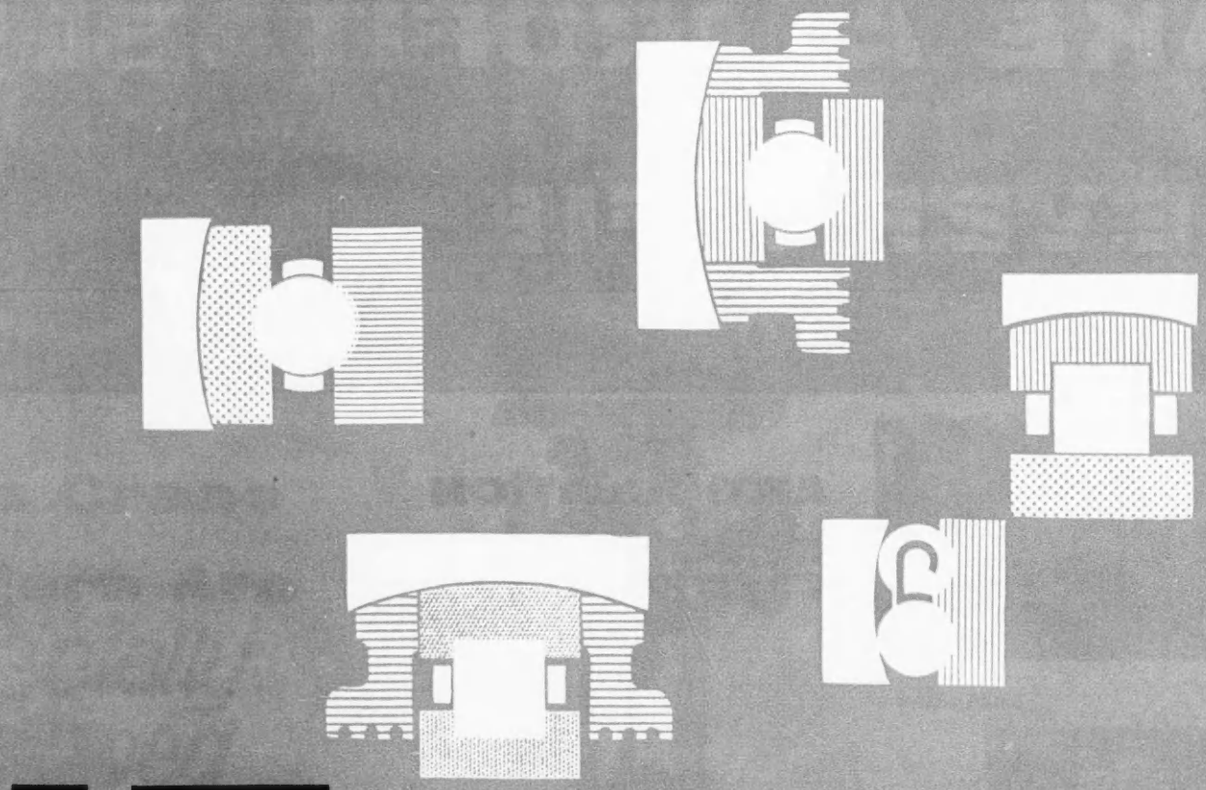


A clean, simple super-structure layout

Safe-load indicator for confidence at all levels.



Finger-tip crane controls for fatigue-free handling.



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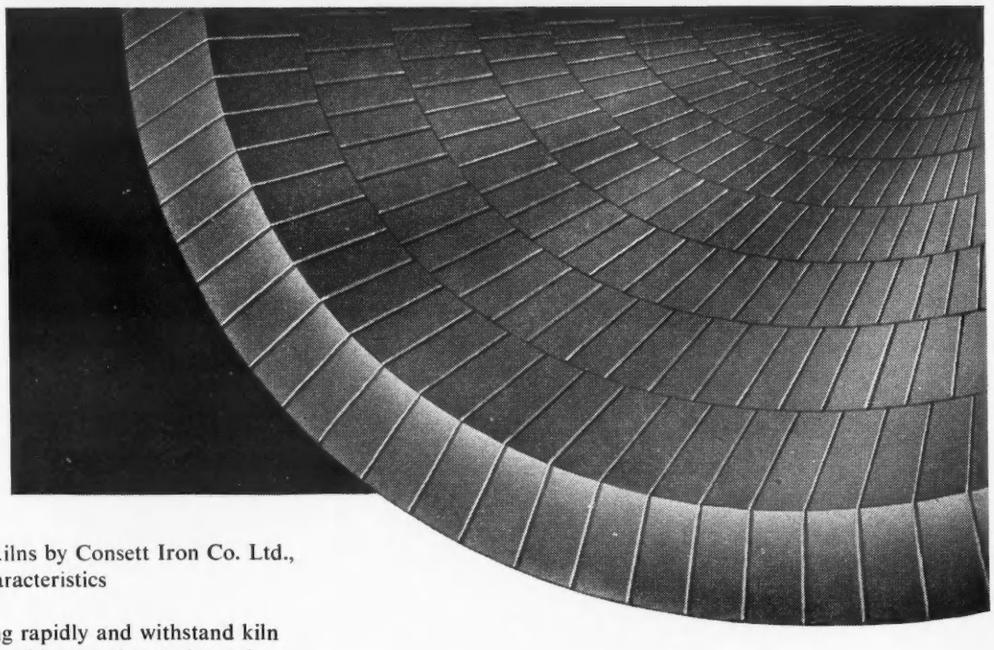
Consett ROTACON Bricks



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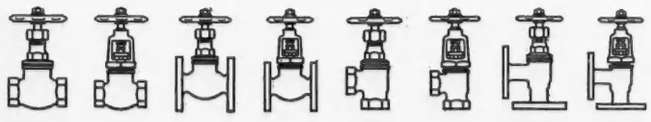

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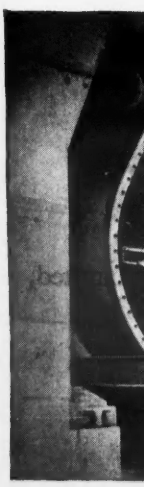

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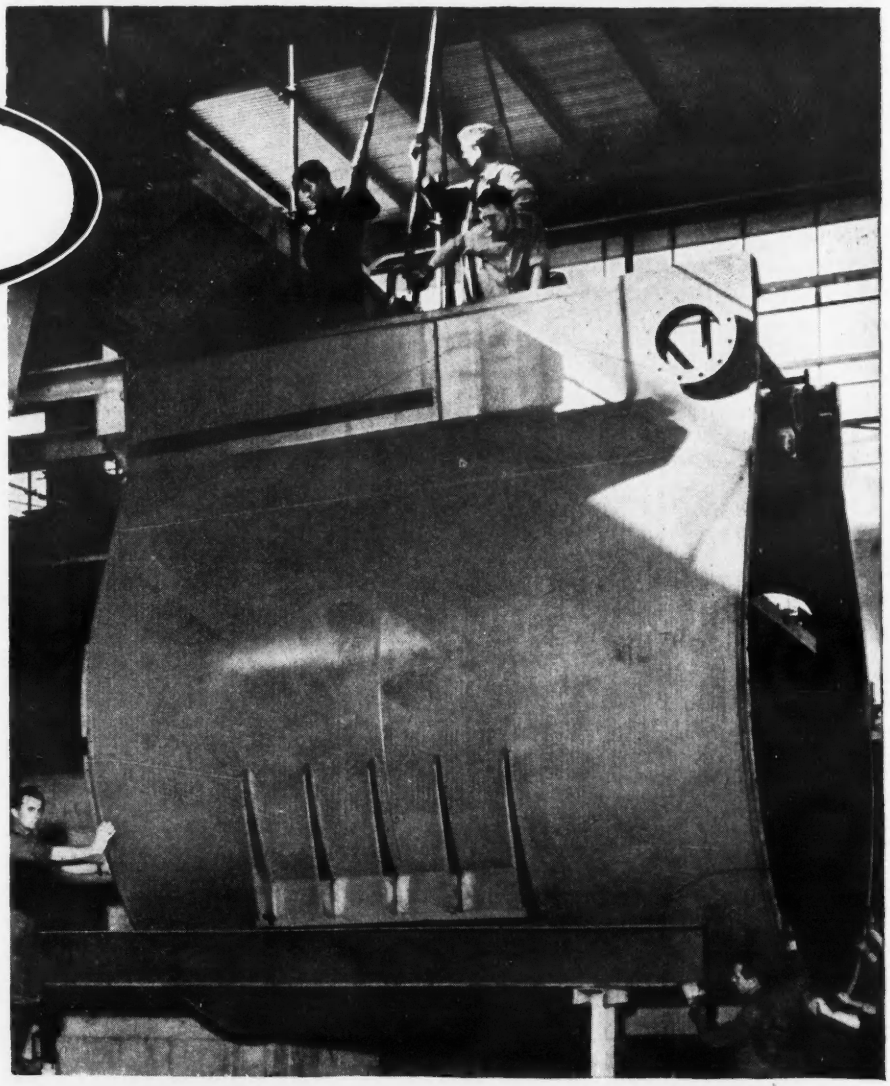
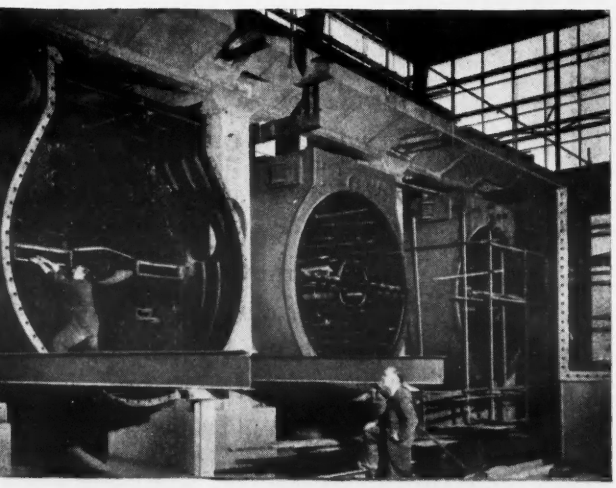
OMPLETE TURBINE-HOUSE QUIPMENT

t of a three-shell surface er being placed in position ley, the commercial nuclear tation now under construc- Gloucestershire by the A.E.I. Thompson Nuclear Energy y.



OR BERKELEY NUCLEAR POWER STATION



al view of three condenser shells in position at Berkeley.

The entire turbine-house heat exchange equipment for the new power station at Berkeley is being supplied by the A.E.I. Turbine-Generator Division, and manufactured at their factory at Germiston Glasgow.

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Associated Electrical Industries Limited

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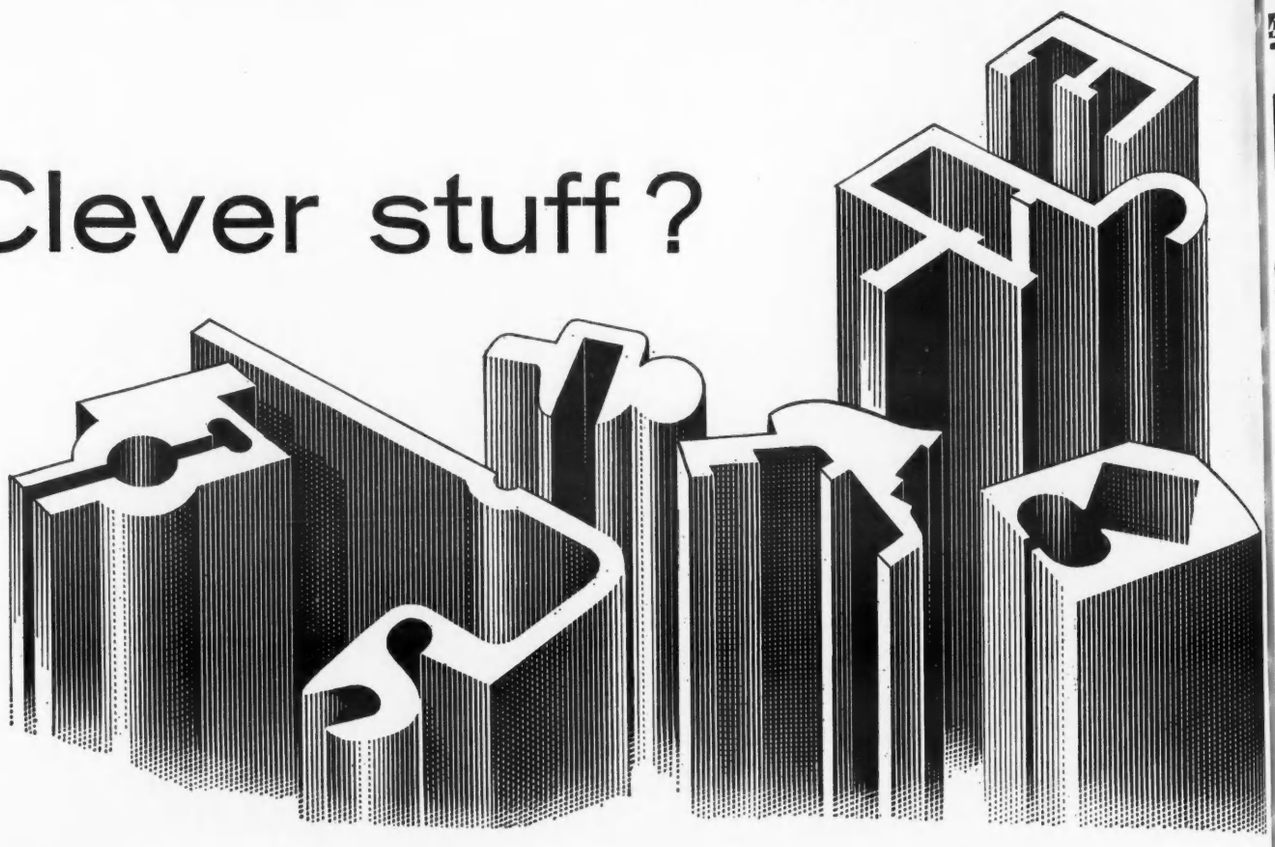
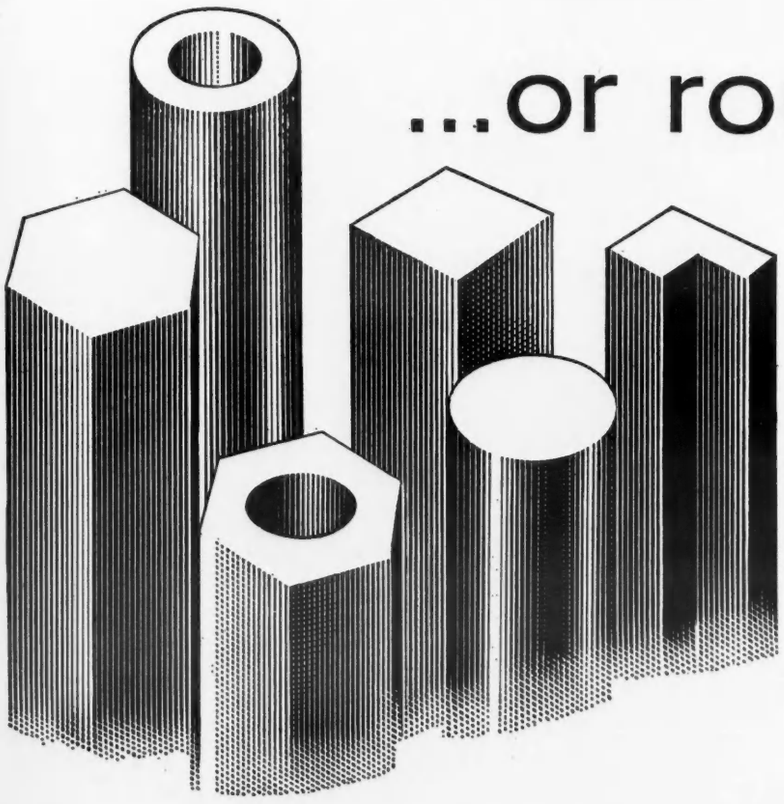


...or routine job?



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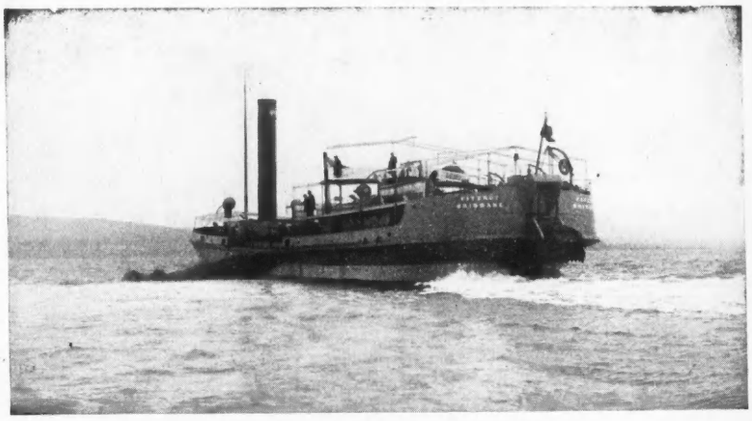

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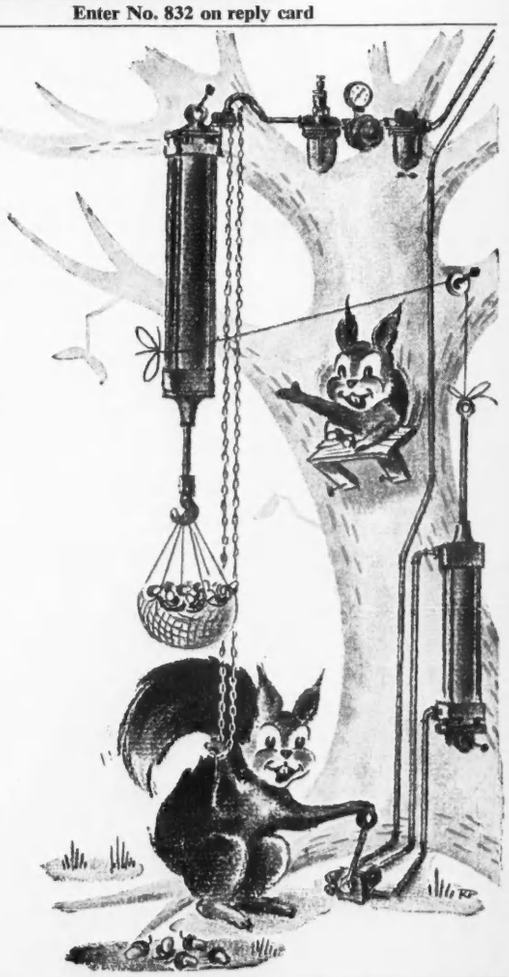

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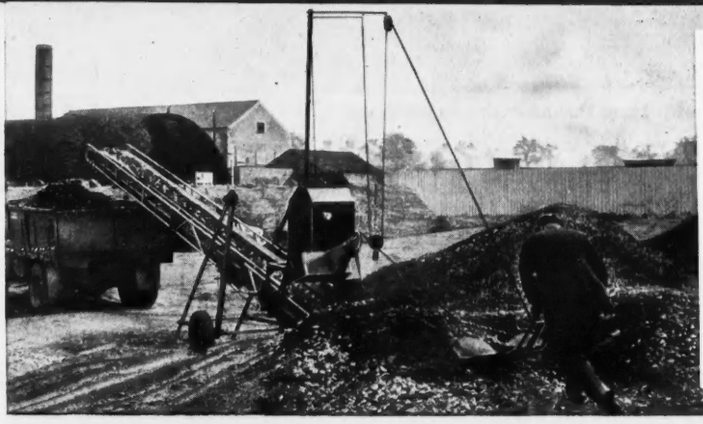

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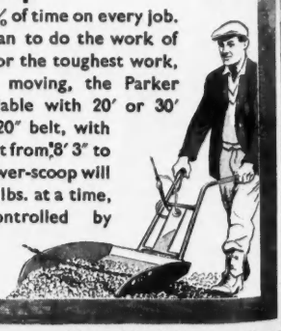

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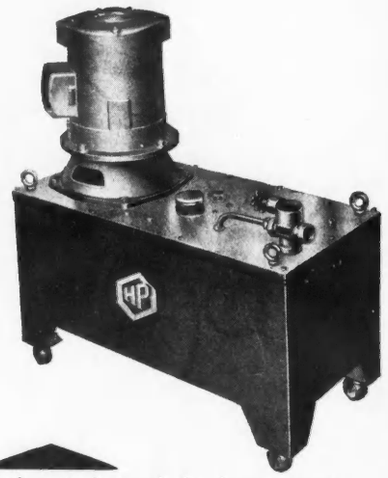
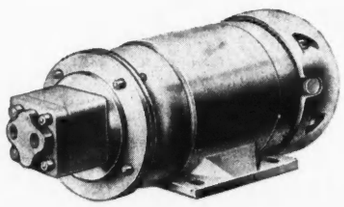


Tank unit designed for larger pump capacities up to 8.5 g.p.m.

Hydraulic gear type pump, close coupled to 1 H.P. Motor.



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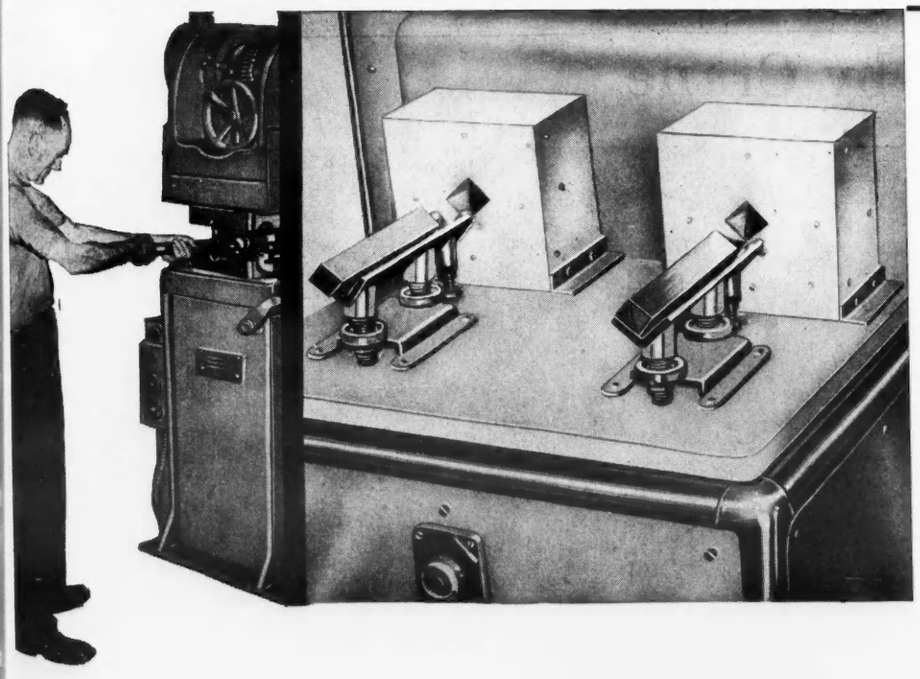

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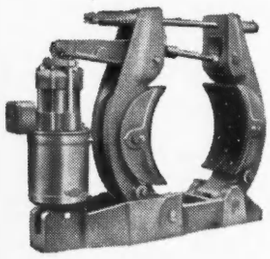

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D27R

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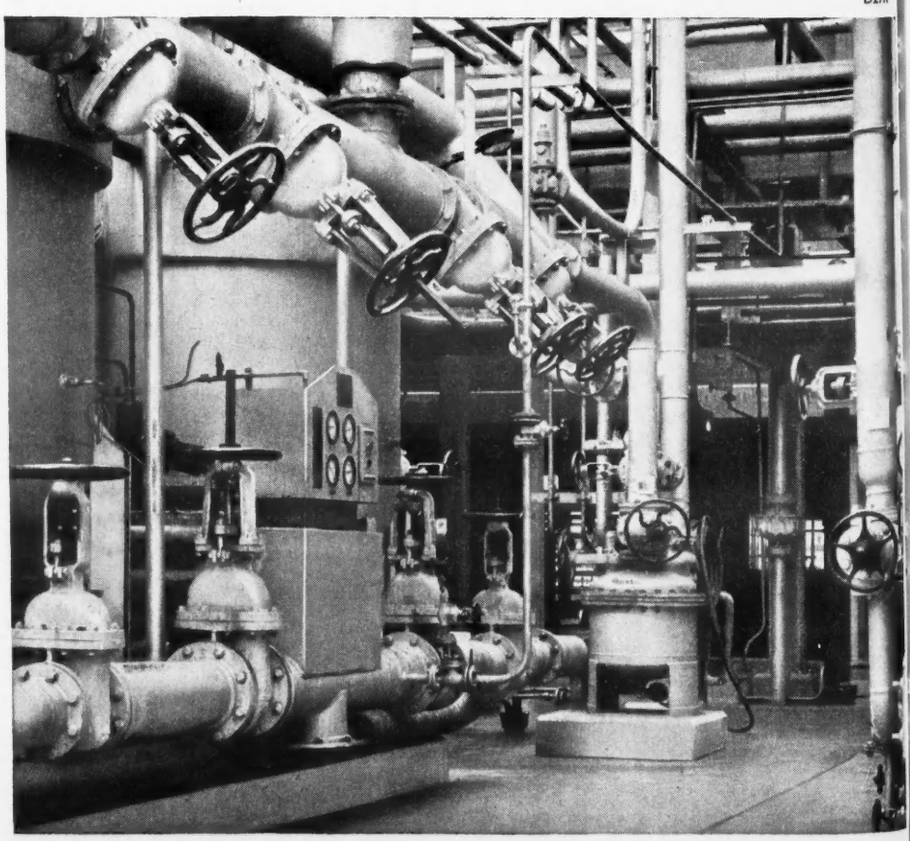

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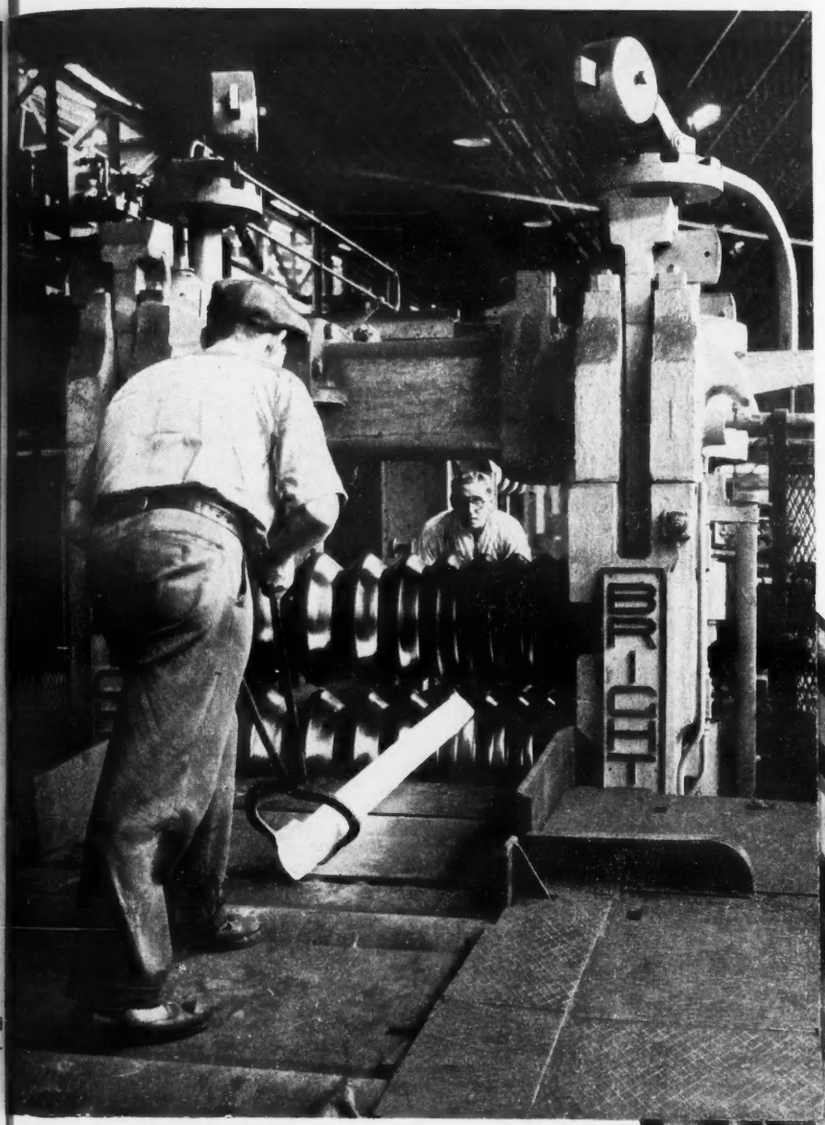

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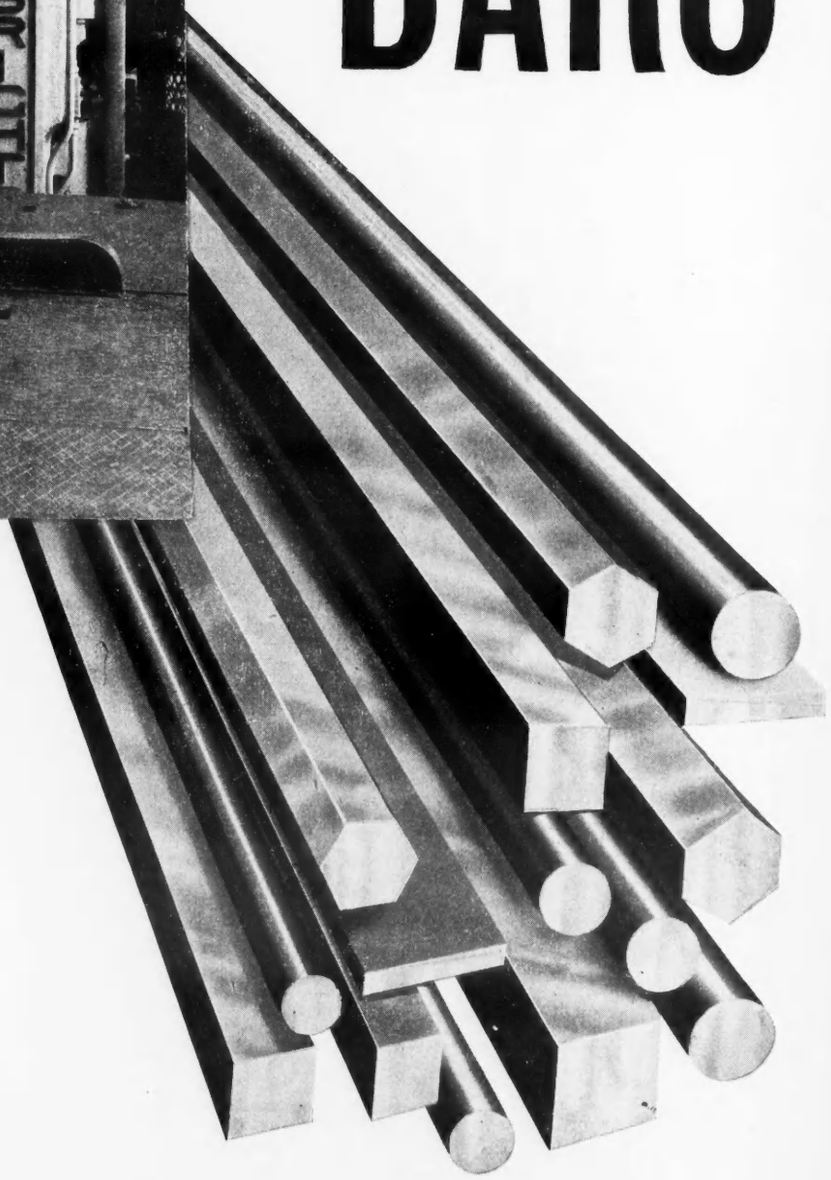

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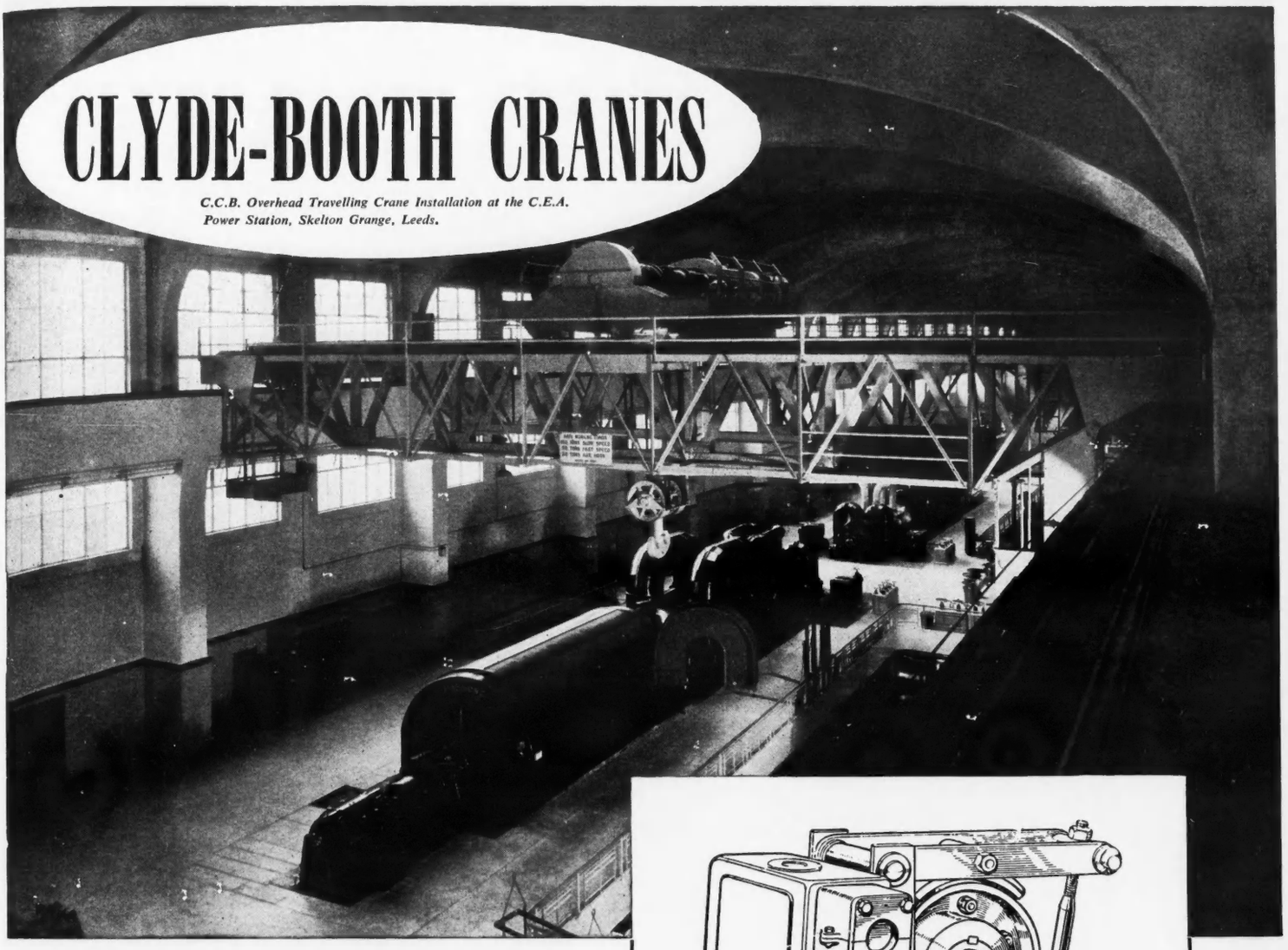

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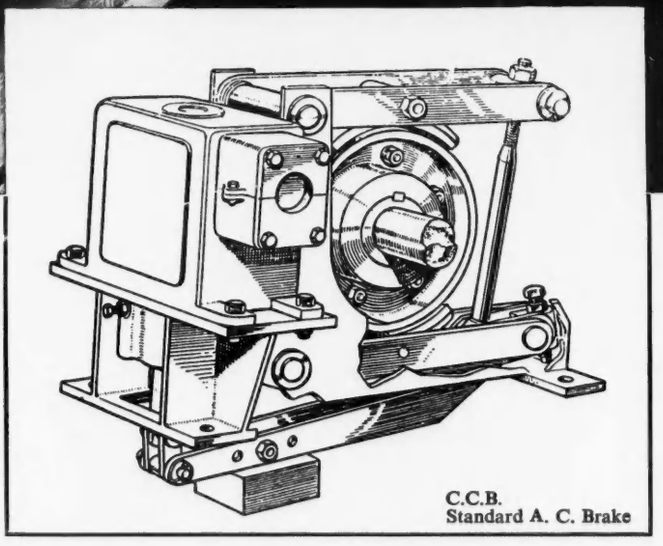

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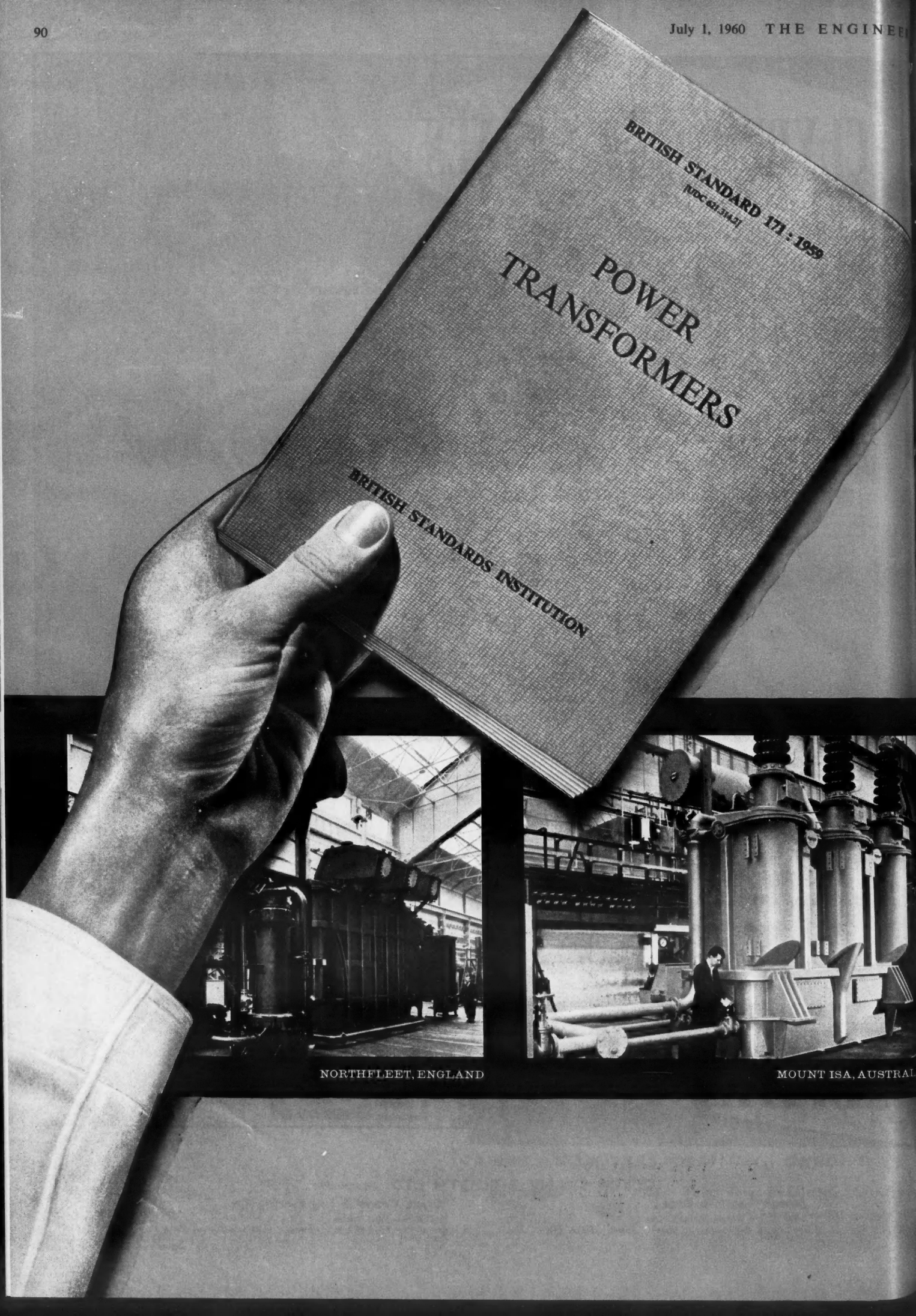
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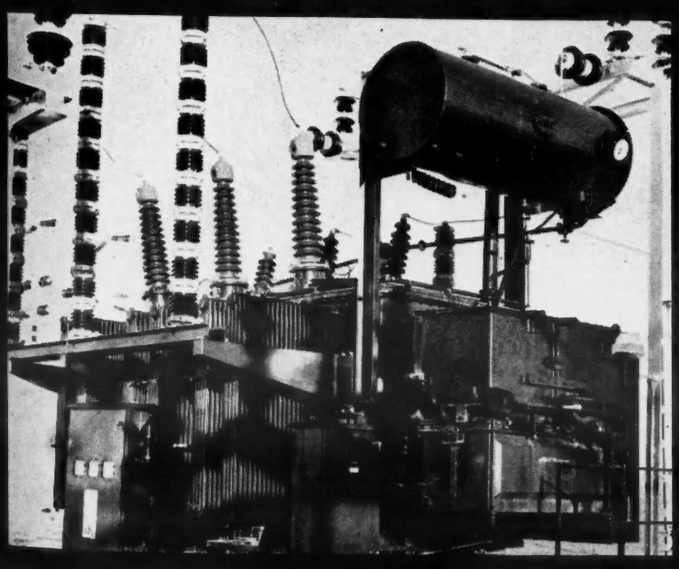

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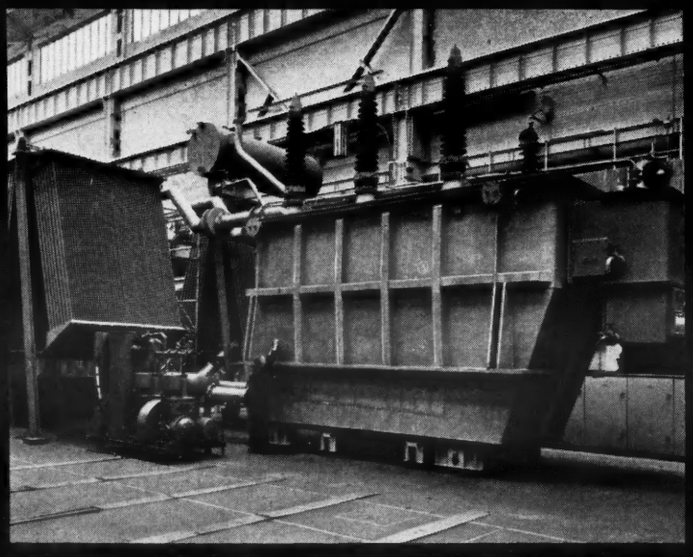

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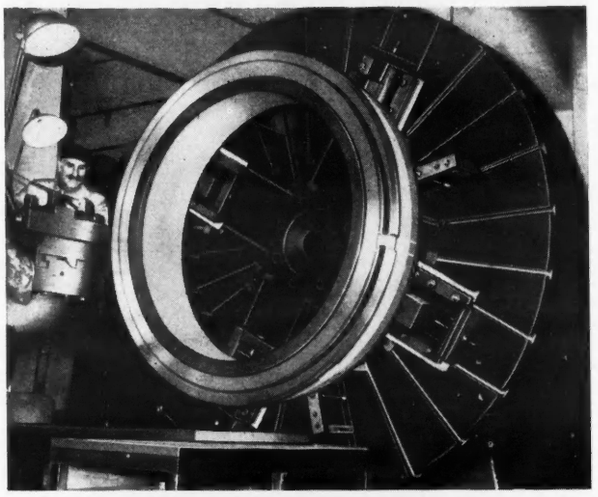
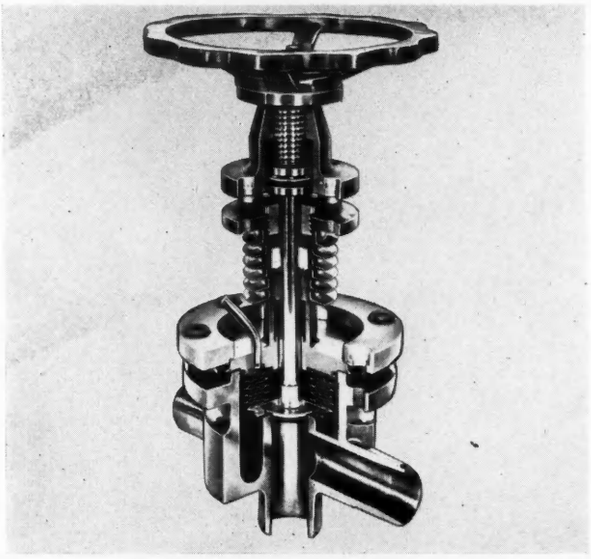


The resistance of "Stellite" to seizure and oxidation, together with its high creep strength is proving invaluable for components used in gas turbines.

Illustration:— Machining "Stellite" faced gas turbine hot ring in the Works of Cantieri del Tirreno, Italy.

"Stellite" is applied by all welding methods and by spray-fusing. It is also available as castings machined to a high degree of accuracy or as precision investment castings.



"Stellite" trim is specified by valve users for applications requiring maximum resistance to heat, corrosion and erosion.

Illustration:— Liquid metal valve with "Stellite" plug designed and developed within the Research and Development Branch of U.K.A.E.A., of Capenhurst. Manufactured by Palatine (Surbiton) Limited.

Literature on "Stellite" cobalt base alloys is available on request.

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Illustration:— Excavating on coal site. "Stellite" is used on bucket edges and teeth

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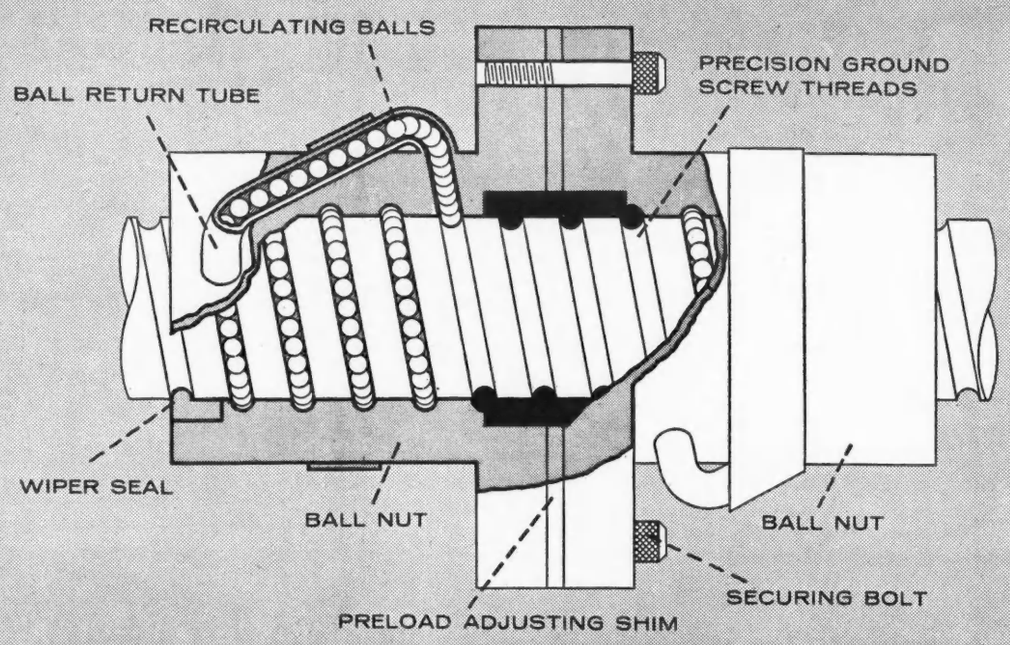

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* *Complete technical and manufacturing co-operation with Beaver Precision Products Inc, Detroit.*

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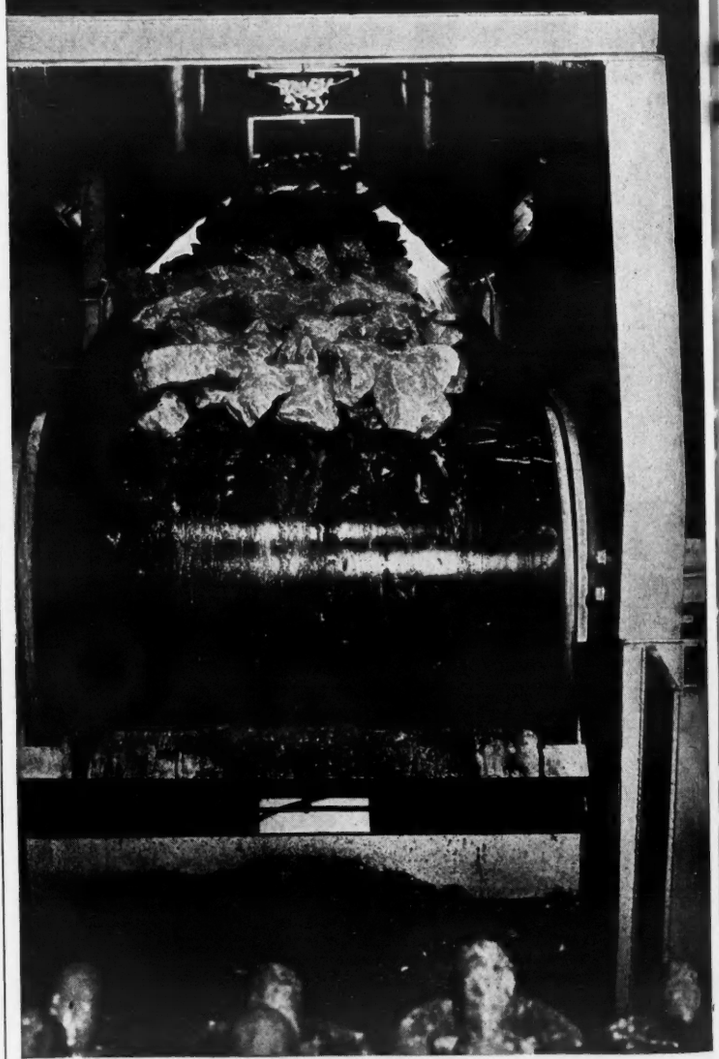

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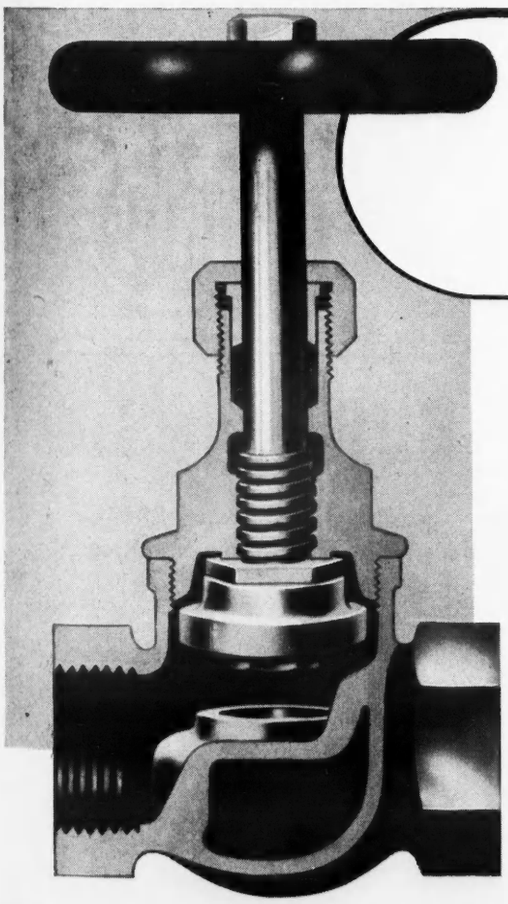

Fig. 13

FEARNAUGHT Renewable Disk Globe Valve by HATTERSLEY for 180 p.s.i. saturated steam

This versatile gunmetal valve is available in a range of sizes from ¼″ to 4″ with screwed or flanged ends in straight or angle patterns.
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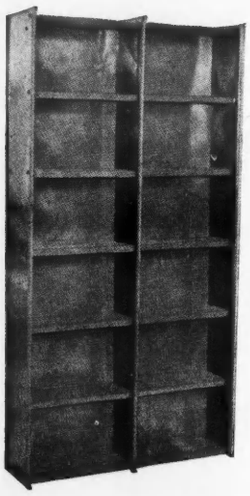

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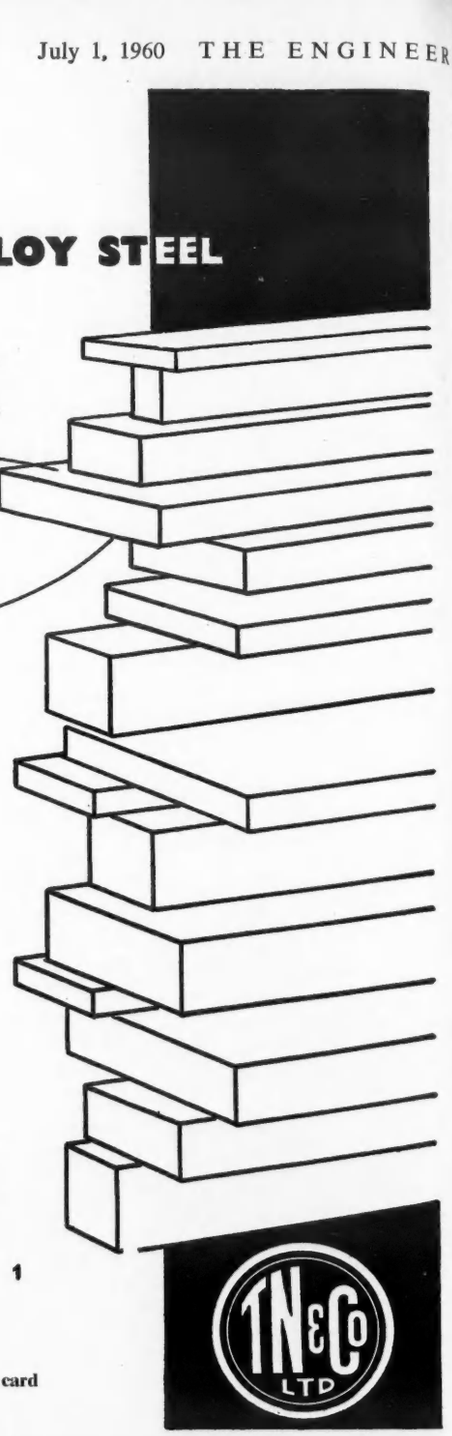

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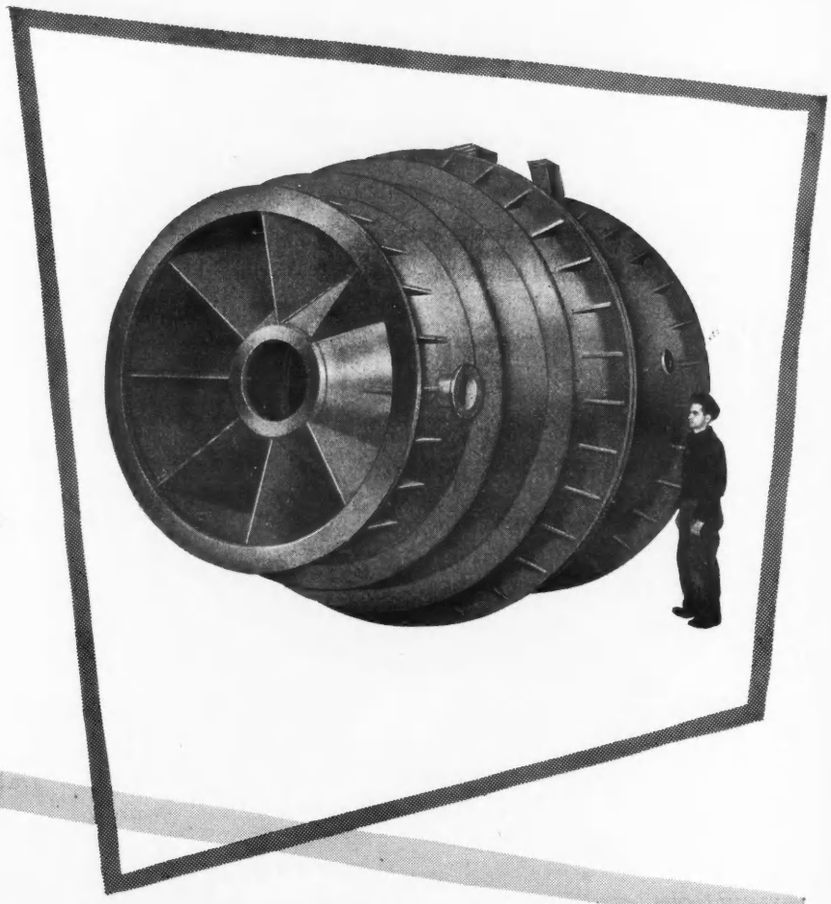

$\frac{7}{8}$" mild steel plate valve casing, weighing 4 tons; in two pieces, a cylinder and a cone; dia. 9' 7" tapering to 6' 2" by 10' 4¼" long.

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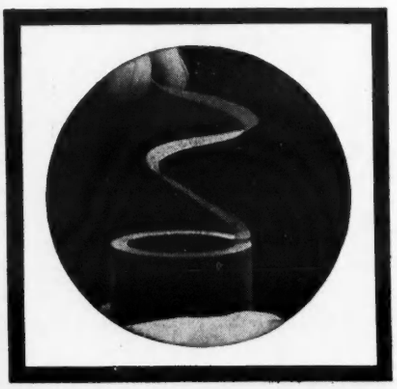

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The standard range of diameters (in any length) covers most applications, and no other filtration material can so readily be adapted to individual requirements for filters, strainers, breathers or separators. Never before has such fine filtration been possible at such low cost and with such flexibility in use.

Tecalemit Ribbon Elements filter to maximum purity

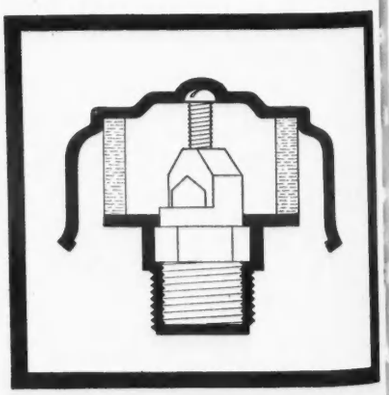
Tecalemit Air Breather Filters

(incorporating Tecalemit Ribbon Filter Elements)

Cheapest—Most efficient—Cleanest to service.

Tecalemit Breathers act as ventilators to provide a free flow of clean air to hydraulic fluid, fuel and oil reservoirs. They give positive protection from airborne contamination to tanks, pumps, valves, cylinder and other engine components. Of the standard types, two are breathers with screwed bodies, and the third is a combined clip-on assembly of breather and filter cap. All are fitted with Tecalemit Ribbon Filter Elements.

Tecalemit Breathers provide pure air cheaply and efficiently



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the authority on filtration

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Loading bridges
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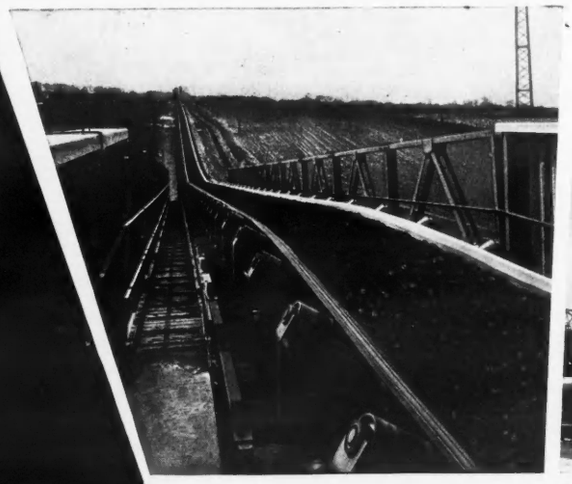

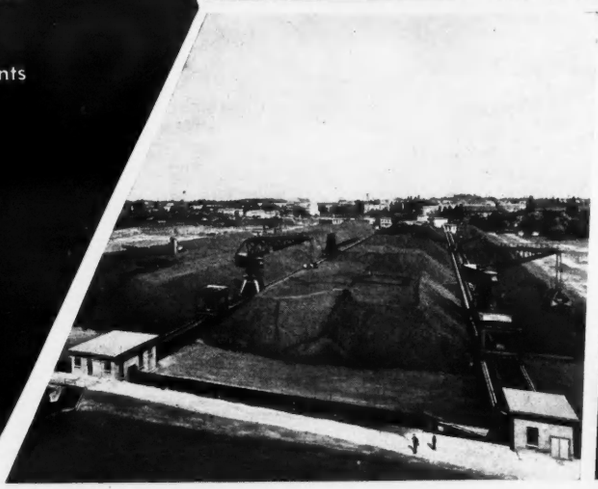

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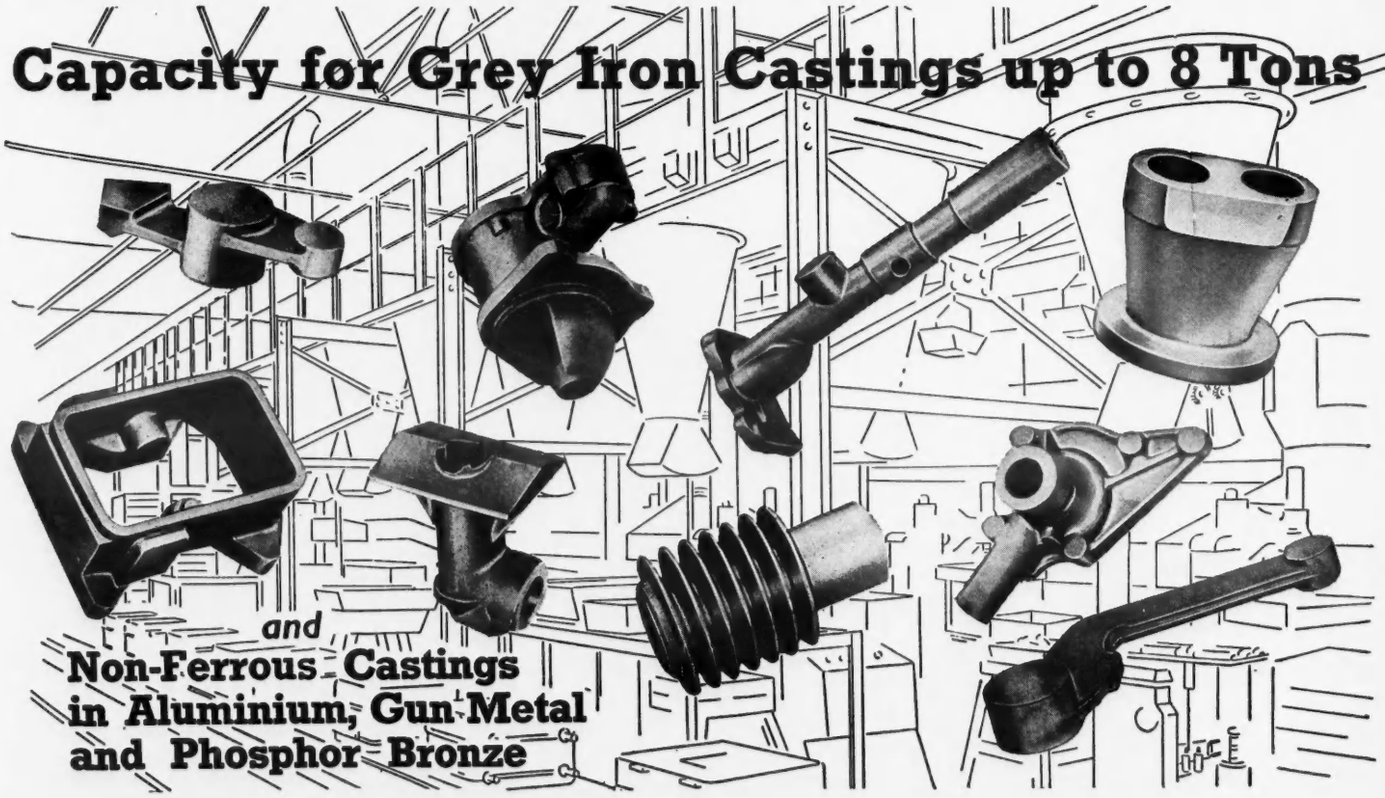

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We can demonstrate this to you on your own equipment.

There are real savings here, particularly as you also get more holes between regrinds.

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MACHINE TOOL EXHIBITION
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SPEEDICUT

"CHIPBREAKER" DRILLS

FIRTH BROWN TOOLS LTD.,
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Time and time again

TIME PAST

Vokes Genspring hangers were introduced to provide constant support for high temperature pipework over a wide range of vertical movement. One of the applications for which they were specified was the support of pipework at the then revolutionary nuclear power stations at Calder Hall and Chapel Cross.

TIME PRESENT

Such was their success that we are now privileged to supply suspension equipment to the five members of the Nuclear Consortia for the five latest Nuclear Power Stations. A new Genspring capable of supporting 97,800 lb. with a 12″ vertical travel has been built mainly for use in Nuclear Power applications.

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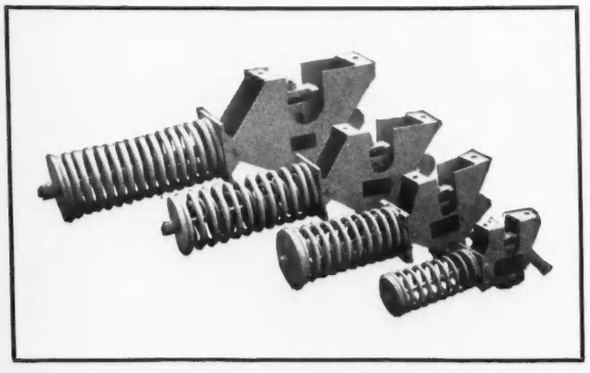
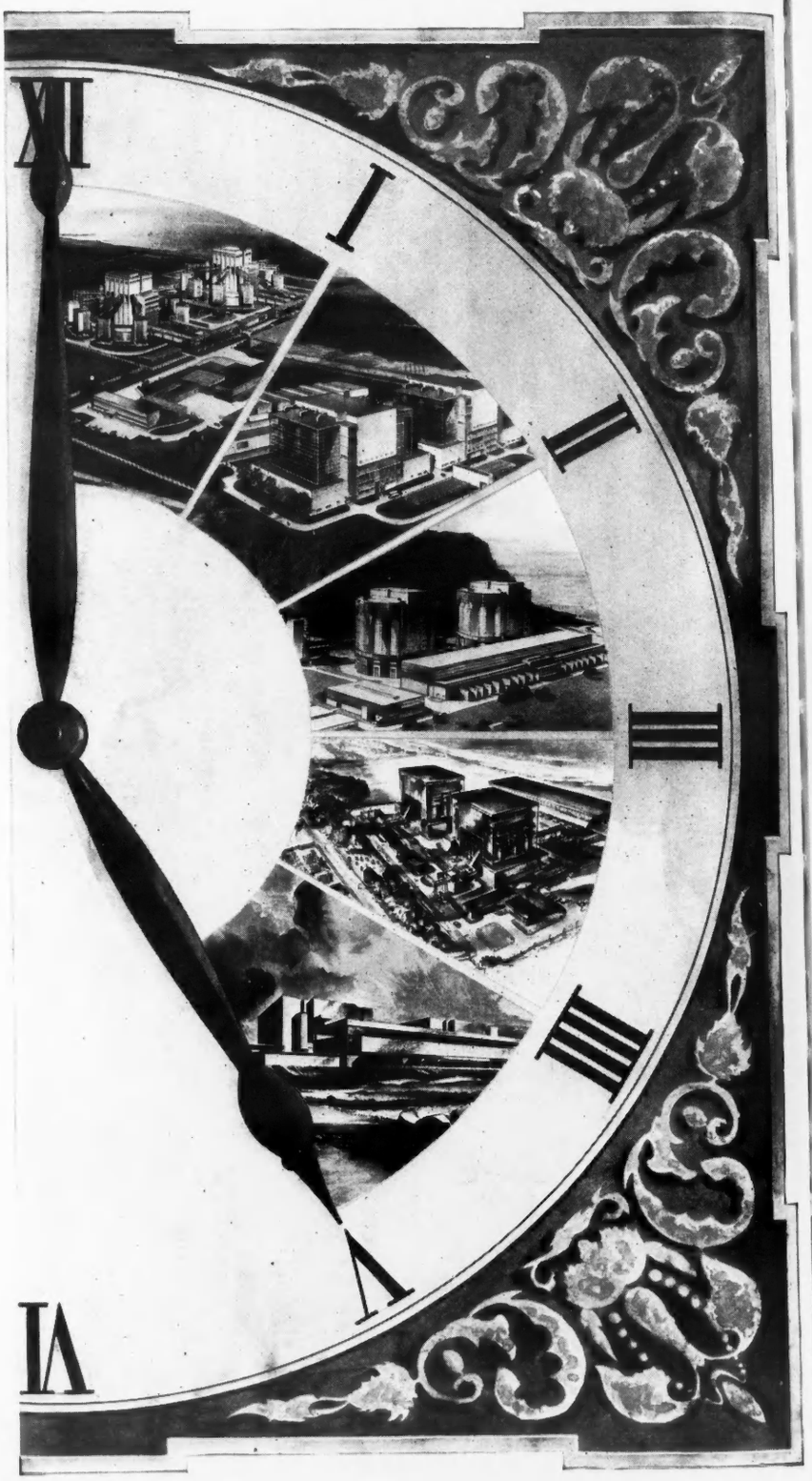
Vokes Genspring have thus built up a unique fund of specialised knowledge which will prove invaluable in overcoming new pipe support problems which the power stations of the future will almost certainly present.

Illustrated below are the M1 to M4 Constant Supports covering loads from 315 lb. to 22,500 lb. and travels from 1.5″ to 12″. The latest addition to the range is Type M7 for loads up to 97,800 lb.





The illustrations above are artists' impressions of the Nuclear Power Stations at Berkeley (A.E.I.—John Thompson Nuclear Energy Co. Ltd.); Bradwell (The Nuclear Power Plant Company Ltd.); Hunterston (G.E.C.–Simon–Carves Group); Hinkley Point (English Electric, Babcock & Wilcox, Taylor Woodrow Atomic Power Group) and Trawsfynydd (Atomic Power Constructions Ltd.)

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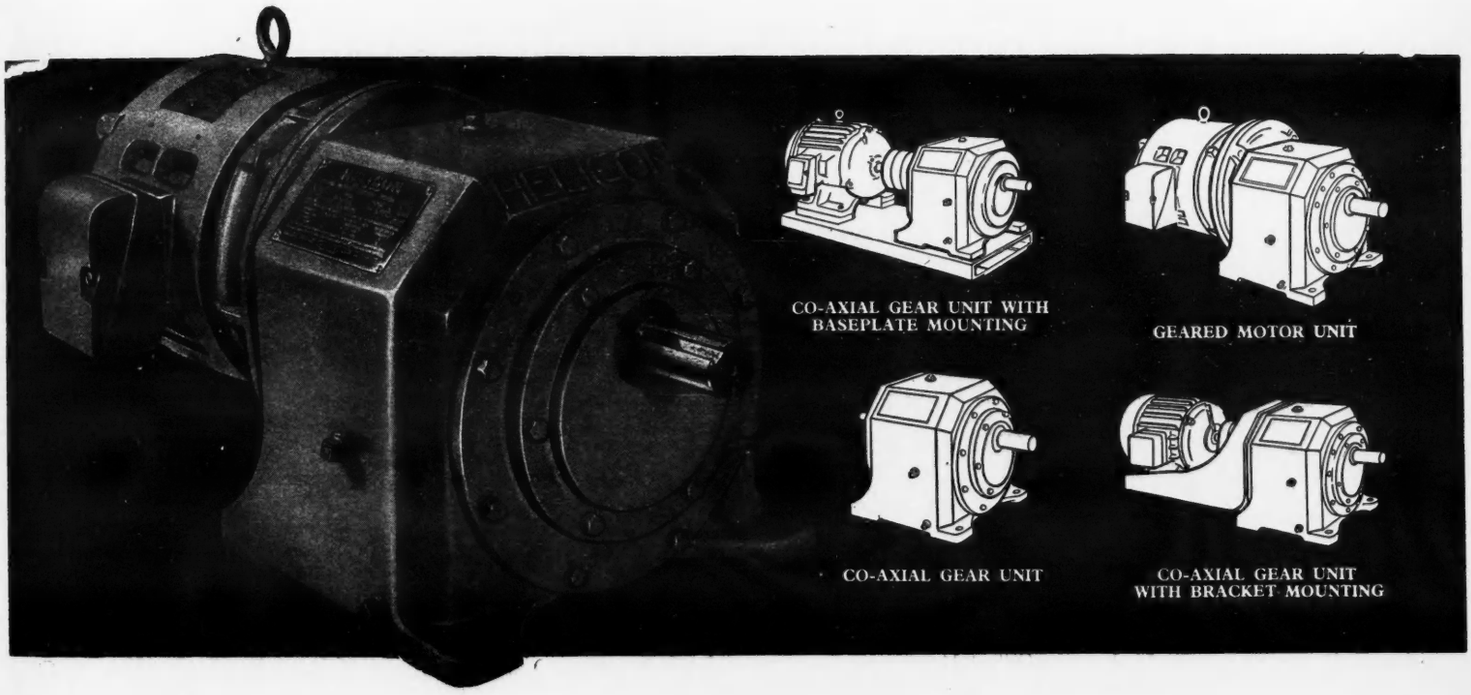
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Helicon geared motors and co-axial geared units are new . . . and all the better for being made by David Brown, the firm with 100 years' experience of gears. That means greater accuracy more reliability with less maintenance — in fact a quiet, compact, sturdy, quality product.

There is a booklet No. F. 444.3 waiting for you. It tells about the range of units covering 34 standard ratios for any drive up to 40 h.p. Write for it to-day.

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geared motors and co-axial geared units

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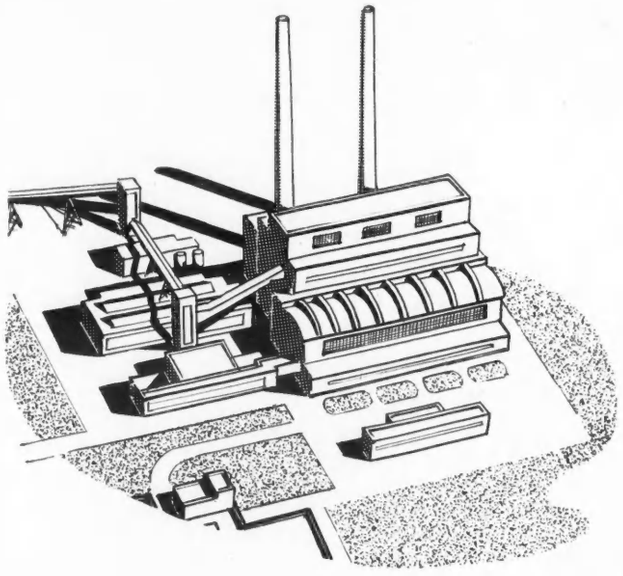
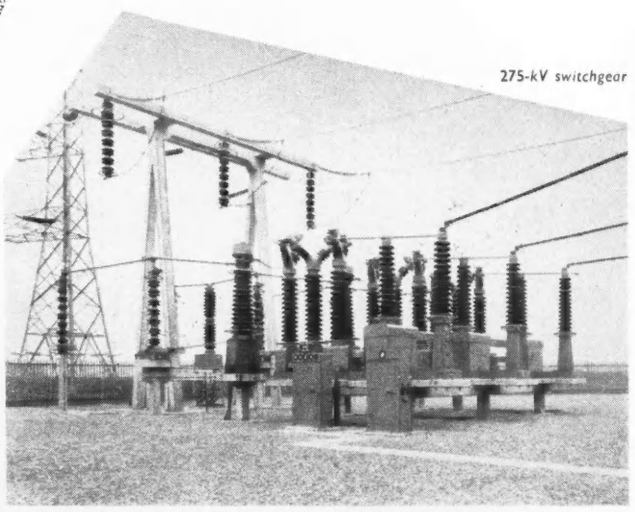
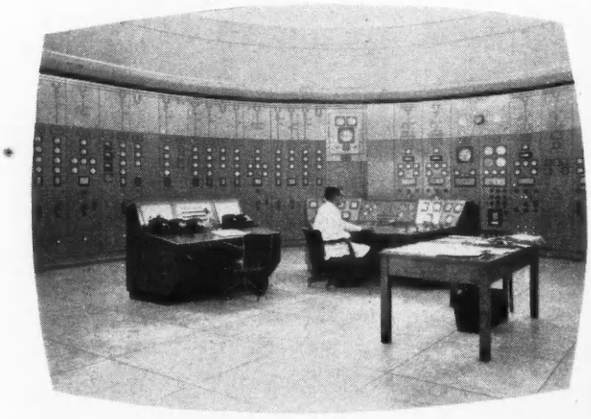


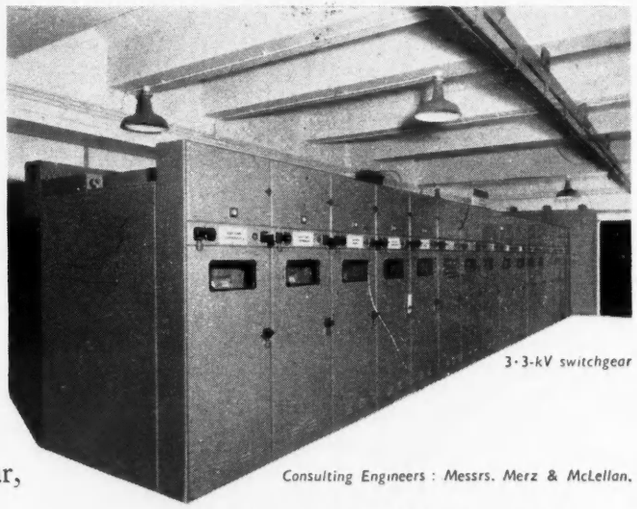
Blyth A
GENERATING STATION



275-kV switchgear



Main control-room



3·3-kV switchgear

Consulting Engineers : Messrs. Merz & McLellan.

Photographs by courtesy of C.E.G.B., North Eastern Division

Reyrolle supplied the 275-kV air-blast switchgear, 66-kV small-oil-volume switchgear, 3·3-kV air-break auxilliaries switchgear, and 415-volt distribution gear together with associated control-equipment.

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The Ferret Autobrator N.400

CREEPS AND DOES NOT REVOLVE—IT DOES ALL THE PUSHING PULLING AND WALKING TO AND FRO FOR YOU ! !

The AUTOBRATOR is a variable frequency oscillator which, when attached to the standard type of tube brush, causes the brush to force its way through the tube so that the operator does not have to push. When the air is switched on the brush is set walking until it reaches the end of the tube, the double thrust action then changes direction and the brush returns in the same way. THE N.400 TRAVELS WITH THE BRUSH TO THE END OF THE TUBE. A QUICK TUG ON THE SAFETY CHAIN REVERSES IT SO THAT IT TRAVELS BACK TO THE OPERATOR.

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Main Propelling Diesel Engines in powers up to

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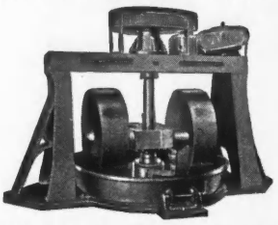

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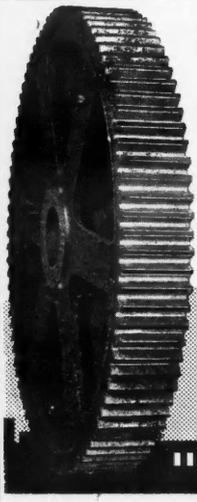

GEARS for every Industrial need . . . .

Spurs, Spirals, Bevels, Racks, Wormwheels, Chainwheels—supplied any size to your specification. You can depend on Sones to supply you with gears, however intricate. Write or phone:—

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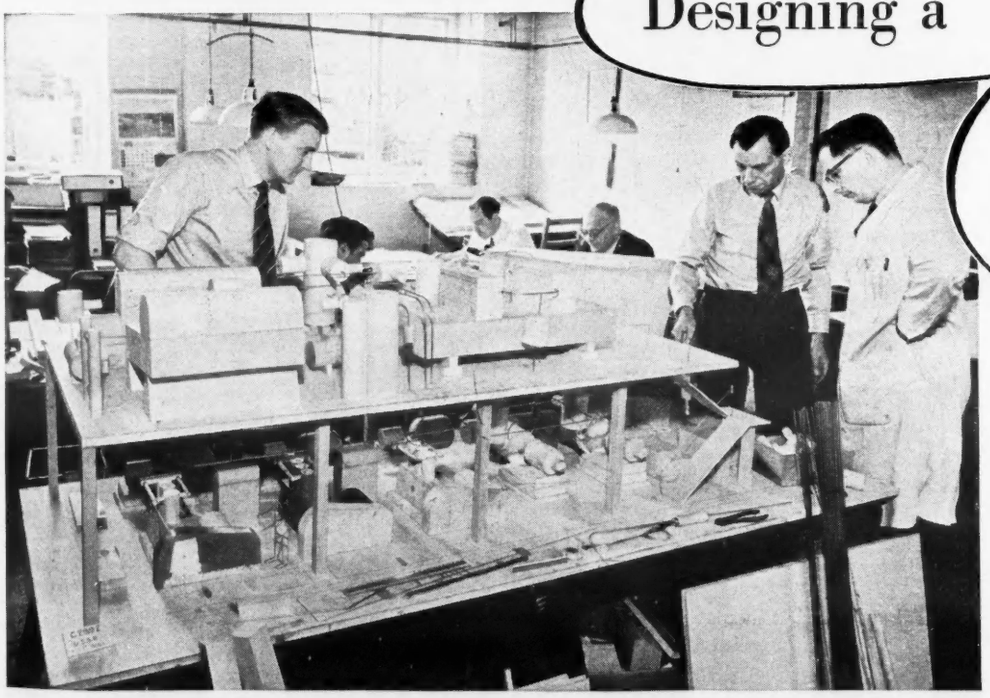
Designing a UDEC Refrigeration Plant



From Flow Diagram . . .
Preliminary Layout . . .
Scale Model . . .
to Final General Arrangement . . .
there is co-ordinated teamwork.

UDEC

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a new BENNIS portable

(photograph by courtesy of the North Thames Gas Board)

The PEGASUS Loadstacker

This combined portable low loader and stacking conveyor can be fed direct from lorries or grabs to convey material to the stockpile. Manufactured in a range of sizes from 35 ft. to 70 ft. belt centres, construction is exceptionally robust yet no counterbalancing is necessary. All sizes are available with electric motor, petrol engine or diesel engine drive. Features include hydraulic raising and lowering of the boom and all four wheels can be swivelled through 90° for lateral movement or arcing with maximum stability.

Write for details and standard prices to the MECHANICAL HANDLING DIVISION

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you spend less... RAISING STEAM!

—for area space-heating, industrial processing, food-factory sterilisation —when you use the

COLTMAN VERTICAL "ECONOMIC" BOILER

the sturdy, trouble-free boiler built by one of the most experienced manufacturers in the boiler-making industry. In combination with an Automatic Stoker, "ECONOMIC" boilers provide one of the CHEAPEST methods of steam production in this country today—and the "ECONOMIC" can be easily adapted for oil-firing if required. Robust in construction, advanced in design, the Coltman "Economic" Vertical Boiler is simple to maintain and has a long, useful working life.

COLTMAN

WALTER W. COLTMAN & CO. (BOILERS) LTD., CENTRAL BOILER WORKS · LOUGHBOROUGH
Telephone: Loughborough 2351 **Telegrams: Boilers, Loughborough**

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British & Foreign Patents & Regd. Designs

Safety *Plus* mobility

Prevent accidents! Augur Safety Steps can be used with perfect confidence. Built for hard wear and adaptable to all types of work. Fitted with retractable castors and Safety Domes. STEPS LOCK AUTOMATICALLY WHEN MOUNTED. Ball-bearing swivel castors for easy movement. Recommended by Safety Officers, Factory Inspectors and Insurance Companies.

Platform Units as illustrated above are built to special requirements and to the same principles as the Augur Safety Steps.

AUGUR Safety Steps. All Welded Tubular Structures. Safety Rail for security. User has both hands free for work.

Take the first step to safety—

Use **AUGUR**

Step on with confidence and speed up your work.

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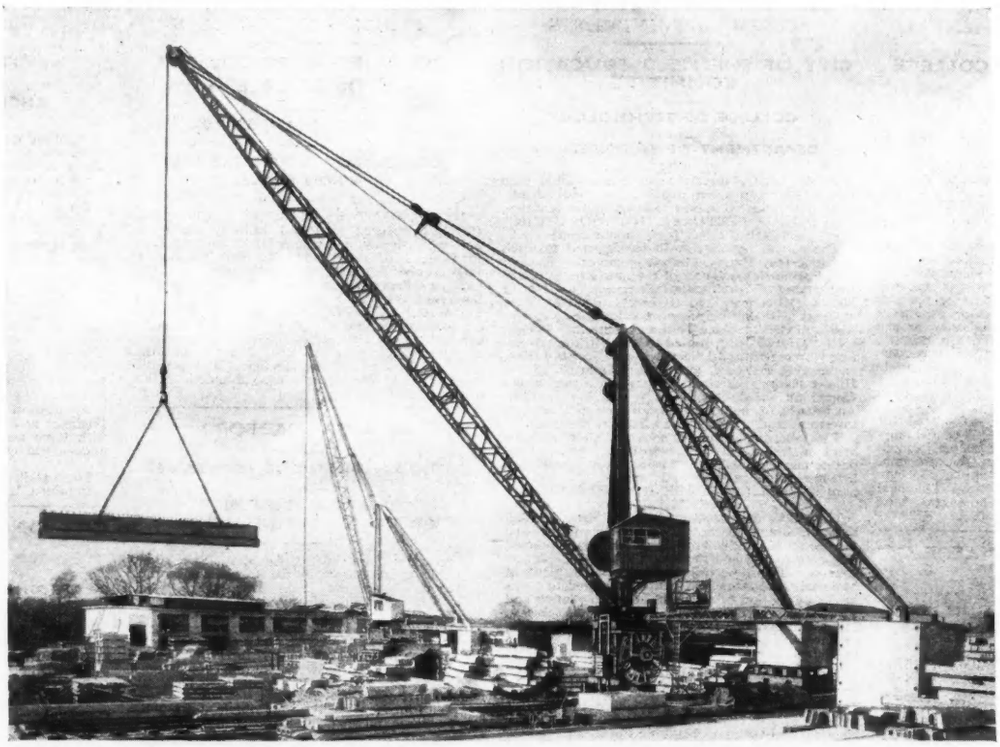
ANDERSON *Cranes*

THE FINEST DERRICK



One Derrick Crane may look the same as another—from a distance. At close quarters the differences are astounding. The cabin interior, alone, clearly establishes ANDERSON design and construction to be supreme. The clean, compact gearing built on unique unit principles, guarantees mechanical efficiency and reliability—and ensures lowest erection and operating costs. The drivers panoramic visibility, centralised easy control and comfort, have to be seen to be believed. High performance and safety are spontaneous—a banksman often superfluous. These and other exclusive features explain why independent examiners are so impressed, and more and more users specify ANDERSON only.

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LEADING MAKERS OF ELECTRIC OVERHEAD TRAVELLING CRANES

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Telephone: MONarch 4629

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Lineage Rate. 4/6 per line of approximately 6 words. Minimum 18/-. **Inch Rate.** 54/- per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

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Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

ROYAL TECHNICAL COLLEGE

SALFORD

SENIOR LECTURER OR LECTURER

Applications are invited for the post of SENIOR LECTURER or LECTURER in MACHINE TOOL TECHNOLOGY in the DEPARTMENT of MECHANICAL ENGINEERING in this College of Advanced Technology.

The person appointed will be expected to teach this and related subjects to undergraduate and post-graduate students of engineering. Applicants should have a degree in engineering, or other high academic qualifications, together with industrial or research and development experience. Teaching experience and experience in the machine tool industry, or as a machine tool specialist in a metal working industry, would be additional qualifications. Staff are encouraged to engage in consulting work in appropriate subjects and to develop contacts with industry.

Salary scales : Senior Lecturer : £1550 rising to £1750 p.a. Lecturer : £1370 rising to £1550 p.a.

Exceptional candidates may be considered for appointment as a PRINCIPAL LECTURER at a salary scale of £1750 rising to £1900 p.a. In all grades, the starting point may be above the minimum.

Further particulars and forms of application may be obtained from the Registrar, Royal Technical College, Salford, 5, Lanc., to whom completed forms should be sent by 9th July, 1960. E5293

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

HEAD OF PRODUCTION ENGINEERING

Applications are invited for the position of HEAD OF PRODUCTION ENGINEERING, to take charge of both the Department of Industrial Engineering and the Production Engineering Workshops. Applicants should be well qualified academically, should have had industrial experience and, preferably, should have had particular responsible experience in Industrial Engineering, in either manufacturing or research fields.

The post offers very great scope for new developments. The College Workshops operate both as an instructional factory and as laboratories in industrial engineering.

The basic salary scale will be £2450 by £50 to £2700, on which pension contributions will be paid. This salary will be supplemented by a very substantial amount for an outstanding man, who is able to give particular service, and for such a man may be greatly in excess of £3000 per annum.

Further particulars and application form may be obtained from the Academic Registrar. (In reply please quote 19/2/C.). E5260

READING TECHNICAL COLLEGE

APPOINTMENT OF MAINTENANCE ENGINEER

Applications are invited from suitably qualified persons for the post of MAINTENANCE ENGINEER at the Reading Technical College. Salary scale : £880 to £1065, with placing according to qualifications and experience. Local Government Superannuation Acts applicable.

Further details and application forms, returnable by 25th July, 1960, obtainable from the Chief Education Officer, Reading Education Committee, Education Office, Blagrave Street, Reading. E5283

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for a LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING to commence duties, if possible, in September, 1960. Applicants should be University Graduates in Civil Engineering and Corporate Members of the Institution of Civil Engineers. Previous teaching experience will be an advantage and encouragement will be given to undertake research work.

Salary scale £1370 by £35 to £1550 per annum, commencing salary being determined by previous experience and qualifications.

Application form and further particulars may be obtained from the Academic Registrar. (In reply please quote 10/C.). E5259

PUBLIC APPOINTMENTS

CITY OF SHEFFIELD EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY

DEPARTMENT OF ENGINEERING

Applicants for the following posts should hold graduate or equivalent qualifications and be adequately experienced in both industry and in teaching.

(a) SENIOR LECTURER IN PRODUCTION ENGINEERING (new appointment)

The person appointed will be expected to teach Machine Tool Theory, Metrology and other Production Engineering subjects of the new scheme of the Institution of Production Engineers to Higher National Certificate and Higher National Diploma students. He will be responsible for the new, very well-equipped Machine Tool and Metrology laboratories. He will be expected to assist in the promotion of research and laboratory work in production engineering subjects, in the development of the Higher National Diploma course and in organising special advanced courses in production subjects. An interest in the application of automatic control to manufacturing equipment will be welcomed.

The following vacancies arise from the appointment of the present holders to higher posts. Corporate membership of the Institution of Mechanical Engineers is essential for both posts.

(b) SENIOR LECTURER IN MECHANICAL ENGINEERING

The holder of this post will be required to teach Strength and Properties of Materials and Applied Mechanics A.1 and S.3 in Higher National Diploma, Higher National and Ordinary National Certificate courses. He will be responsible for the Strength of Materials laboratory and will be expected to assist in the promotion of research, laboratory work and special advanced courses in relevant subjects. Interest in and knowledge of experimental work in the mechanical deformation of metals will be welcomed.

(c) SENIOR LECTURER IN MECHANICAL ENGINEERING

The holder of this post will be required to teach Theory of Machines and Applied Mechanics A.1 and S.3 in the Higher National Diploma, Higher National and Ordinary National Certificate courses. He will be responsible for the Theory of Machines and Applied Mechanics laboratories and will be expected to assist in the promotion of research, laboratory project work and special advanced courses in relevant subjects. A knowledge of and interest in automatic control devices will be welcomed.

It is desirable that the successful candidates should take up duties on 1st September, 1960.

Salary : £1550 by £50 to £1750 per annum.

Application forms, obtainable from the undersigned (s.a.e.) at P.O. Box 67, Sheffield, 1, should be returned within 14 days of the appearance of this advertisement.

T. H. TUNN,
Director of Education.
E5191

ROYAL TECHNICAL COLLEGE, SALFORD

DEPARTMENT OF MECHANICAL ENGINEERING

RESEARCH IN PRODUCTION TECHNOLOGY AND MACHINE TOOLS OR MACHINABILITY

ASSISTANT LECTURER

Applications are invited for an appointment as ASSISTANT LECTURER. The person appointed will be engaged in teaching and demonstrating in mechanical engineering, but will for an initial period spend most of his time in carrying out research as a member of a research team supported by a D.S.I.R. research grant in, either—

(a) mechanical vibrations of machine tools
or (b) in the machinability of materials.

The choice of subject will depend upon the applicant's experience.

Applicants should have good academic qualifications and some research experience in a corresponding or related field.

Salary range : £700 rising to £1150 p.a., plus allowances for degree and approved training. Commencing salary dependent on previous experience.

Further particulars and forms of application may be obtained from the Registrar, Royal Technical College, Salford, 5, Lancs., to whom applications should be returned by 15th July, 1960. E5292

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SHRIVENHAM, BERKS

EXPERIMENTAL OFFICERS AND A.E.O'S (MALE)

EXPERIMENTAL OFFICERS and A.E.O's (MALE) required at Royal Military College of Science, Shrivenham, Berks, as DEMONSTRATORS in Civil, Mechanical and Electrical Engineering, Physics and Metallurgy. Qualifications : G.C.E. (A.L.) ; Pass Degree ; H.N.C. or equivalent. Salary ranges : E.O. (minimum age 27) £954 to £1166. A.E.O. £382 (age 18) to £830 p.a. Possibility of pensionable posts and promotion. Quarters available at the College for single men ; possibility of housing for married men. Application forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A289/OA. E5266

CITY OF BRADFORD

SENIOR ENGINEERING ASSISTANTS

POST Nos. 18 and 201
GRADE A.P.T. IV (£1065 to £1220)

Applications are invited for the above superannuable appointments in the City Engineer and Surveyor's Department.

Candidates should preferably hold an Engineering Degree and be A.M.I.C.E./A.M.I.Mun.E. For Post 18 they should have had special experience in design of reinforced concrete and steel structure for multi-storey flat construction and for Post 201 have had good general experience in municipal works, especially the reconstruction, improvement and maintenance of highways.

Applications on forms to be obtained from the City Engineer and Surveyor, Town Hall, Bradford, 1, together with three testimonials, must be received by the undersigned by 15th July, 1960.

HENRY PATTEN,
Town Clerk.
Town Hall,
Bradford, 1. E5238

UNITED BIRMINGHAM HOSPITALS

THE GENERAL HOSPITAL

ASSISTANT ENGINEER

Applications are invited for the post of ASSISTANT ENGINEER at the General Hospital (363 beds) and the Jaffray Hospital (54 beds). Salary £570 to £700 per annum, conditions of service as laid down by P.T.B. Whitley Council.

Applicants should be thoroughly experienced in the maintenance of steam boiler plants, heating and electrical services, &c. The possession of a recognised engineering certificate would be an advantage.

Applications stating age, experience and qualifications together with the names and addresses of two referees should be sent immediately to the House Governor, General Hospital, Steelhouse Lane, Birmingham, 4. E5253

CITY OF NOTTINGHAM

WATER DEPARTMENT

APPOINTMENT OF TWO CIVIL ENGINEERING ASSISTANTS

Applications for the above permanent, pensionable appointments are invited from Engineering Graduates and/or Corporate Members of the Institution of Civil Engineers with five years engineering experience, preferably with a Water Undertaking. The Department has in hand a varied programme of new works estimated to cost £1¼ millions, offering considerable opportunities for gaining valuable experience. Salary, dependent upon qualifications and experience, in Grade A.P.T. V, £1220 by £55 by £50 (2) to £1375.

Applications, with names of two persons to whom reference may be made, to Engineer and General Manager, Water Department, Castle Boulevard, Nottingham, not later than 16th July, 1960.

T. J. OWEN,
Town Clerk.
The Guildhall,
Nottingham. E5272

PUBLIC APPOINTMENTS

CITY OF BRADFORD

ENGINEERING ASSISTANTS

Applications are invited for the following superannuable appointments in the City Engineer and Surveyor's Department on the grades indicated :—

(a) SENIOR ENGINEERING ASSISTANTS, Posts 13 and 119 Special Grade (£785 to £1070).

(b) ENGINEERING ASSISTANTS, Posts 35 and 120 A.P.T. I or Special (£610 to £765 or £785 to £1070).

(c) JUNIOR ENGINEERING ASSISTANTS, Posts 52, 63 and 65 (A.P.T. I (£610 to £765)).

Applicants for (a) should preferably hold an Engineering Degree, be A.M.I.C.E./A.M.I.Mun.E. and have had a good general civil engineering training.

Applicants for (b) should have completed their professional training. Salary on Special Grade if holding an Engineering Degree or A.M.I.C.E. or A.M.I.Mun.E.

Applicants for (c) should have completed professional training and had experience in Municipal and/or Civil Engineering.

Application forms obtainable from the City Engineer and Surveyor, Town Hall, Bradford, 1, with three testimonials, must be received by the undersigned by 15th July, 1960.

HENRY PATTEN,
Town Clerk.
Town Hall,
Bradford, 1. E5237

CITY OF BIRMINGHAM SALVAGE DEPARTMENT

APPOINTMENT OF DEPUTY CHIEF ENGINEER

Applications are invited for the post of DEPUTY CHIEF ENGINEER in the above Department at a salary within the range £1220 to £1375.

Candidates must be Corporate Members of the Institution of Mechanical Engineers, and the person appointed will be responsible for the installation and maintenance of the mechanical and electrical plant at the various Refuse Disposal and Salvage Works of the Department.

Full details of the appointment may be obtained from the undersigned, to whom completed applications must be delivered not later than MONDAY, 18th JULY, 1960.

ALAN E. BARTON,
General Manager.
Civic Centre,
Broad Street,
Birmingham, 1. E5286

GOVERNMENT OF JAMAICA

PUBLIC WORKS DEPARTMENT

EXECUTIVE ENGINEER (MECHANICAL)

Under the Director of Electrical and Mechanical Services to control the maintenance and allocation of heavy earth-moving units, vehicles and general mechanical plants ; to carry out a statistical analysis of the operating cost of all equipment ; to co-ordinate with the Executive Engineer in charge of Workshops in the ordering of new equipment, &c.

Contract appointment for one tour of three years. Salary range £1400 to £1600 a year. Gratuity 20 per cent of salary. House provided at reasonable rent. Free passages.

Candidates up to 50 years, must be A.M.I.Mech.E., with relevant knowledge and experience.

Write to Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD. 112/32/021/D4. E5273

MINISTRY OF TRANSPORT

CIVIL ENGINEERS

Pensionable posts for men and women at least 25 and under 35 on 1st January, 1960 (extension for regular Forces service, Overseas Civil Service, established civil service, and temporary Government service as Civil Engineer). Candidates must have achieved Corporate Membership of Institution of Civil Engineers or passed examinations necessary for attaining such membership. Experience in road and bridge construction essential ; knowledge of Highway Authorities' procedure desirable. Salary (men, London) £830 to £1125 according to age, rising to £1300. Promotion prospects. Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S/64. E5275

PUBLIC APPOINTMENTS

MINISTRY OF AVIATION

ENGINEERS, CHEMISTS/METALLURGISTS, AS TECHNICAL ASSISTANTS

Ministry of Aviation require ENGINEERS, CHEMISTS/METALLURGISTS, AS TECHNICAL ASSISTANTS to undertake training for executive responsibility and practical use of tools of management at research and development and other establishments and branches in various parts of United Kingdom situated mainly in S. and S.W. and Home Counties. Duties connected with work on guided weapons, aircraft development, electronic equipment. Qualifications : Preferably not more than 32 years of age (age deduction for Regular service in H.M. Forces). British of British parents. Engineers : Engineering apprenticeship and exemptions from Parts I and II of Associate Membership or Fellowship of Institutions of Civil, Electrical or Mechanical Engineers or Royal Aeronautical Society. Chemists : suitable training and honours degree in chemistry, physics or metallurgy, exemption from graduate membership examinations of the Royal Institute of Chemistry, Institute of Physics or Institution of Chemical Engineers. Candidates required to produce documentary evidence of qualifications on interview. Opportunities for promotion and establishment in professional classes for appropriately qualified candidates through Civil Service Competitions. A technical Assistant should be worthy of promotion to basic professional rank after three years. Salary : £595 (age 21) to £950 (National male rate) according to age and location. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C.516/OA. E5276

WEAR AND TEES RIVER BOARD

SENIOR ASSISTANT ENGINEER

A.P.T. GRADE IV
(£1065 to £1220 p.a.)

Applications are invited for the above vacancy from Chartered Civil Engineers or Graduates with experience in the design and execution of river improvement schemes. A good knowledge is required of survey work and hydraulic and structural calculations. Experience of direct labour work is desirable. The commencing salary will be fixed in accordance with experience and qualifications. The successful candidate will be required to provide and maintain a car not exceeding 10 h.p. (1199 c.c.) with N.J.C. Essential Users' Allowances. Assistance in the purchase will be given if required. The appointment is pensionable and will be subject to the Local Government Superannuation Act, 1953, and to medical examination. Assistance in obtaining a house to rent can be given to persons not already residing in the Darlington area. Application forms are obtainable from the Chief Engineer, Mr. C. Clay, B.Sc., A.M.I.C.E., at this address and should be returned to him not later than 16th July, 1960.

J. E. LAVEN.
Clerk & Chief Financial Officer.
" Greencroft East ",
158, Coniscliffe Road,
Darlington E5242

THAMES VALLEY WATER BOARD

APPOINTMENT OF CLERK/TREASURER

The Thames Valley Water Board invite applications for the post of CLERK/TREASURER. Applicants must be professionally qualified accountants, preferably Chartered Municipal Treasurers and thoroughly experienced in the financial work of a large water undertaking. A legal or secretarial qualification will be regarded as an additional qualification.

Applicants must not have attained their 45th birthday. The inclusive salary will be in accordance with the Lettered Scale H of the Joint Negotiating Committee for Chief Officers of Local Authorities—£2195 by £60 (4) by £40 (1) to £2475 per annum. The Board would be prepared to consider a commencing salary in excess of £2195 per annum in special circumstances according to the qualifications and experience of applicant. Travelling and subsistence expenses will be paid according to the Board's approved scale.

A statement of the terms and conditions of the appointment and of the duties of the post may be obtained on application to me. Applications giving particulars of qualifications and experience should be delivered to me not later than 23rd July, 1960.

Canvassing in any form, direct or indirect, will be regarded as a disqualification, and applications are to be sent to the undersigned only.

G. F. DARLOW,
Clerk to the Board.
Town Hall,
Reading. E5290

NORTH THAMES GAS BOARD

MONCK STREET, WESTMINSTER, S.W.1.

SENIOR DRAUGHTSMEN

Applications are invited for the above appointments in North Thames Gas Board, at Monck Street, Westminster, S.W.1, for the design and detailing of any of the following :—

(a) Reinforced concrete structures and foundations.
(b) Coal and Coke Handling and Screening Plant.
(c) Steel structures.
(d) Mechanical Plant and pipework associated with gasworks.

The appointments will be permanent and the successful candidates will be required to join the Board's contributory pension scheme.

Salaries will be in accordance with qualifications and experience, but not less than £1000 per annum.

Applications, stating age, qualifications and experience should be sent to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street W.8, quoting reference TE/887. E5289

PUBLIC APPOINTMENTS

CITY OF NOTTINGHAM

APPOINTMENT OF CITY ENGINEER AND SURVEYOR

SECOND ADVERTISEMENT

Applications are invited from persons who have the necessary experience and qualifications for the appointment of CITY ENGINEER AND SURVEYOR at a salary within the scale of £3340 rising by one increment of £115 and two further increments of £110 to £3675 per annum, the commencing point to be fixed according to the circumstances.

The gentleman appointed will be required to devote the whole of his time to the duties of the office and will not be permitted to hold any other appointment or engage in any other work.

The appointment carries superannuation and the selected applicant will be required to pass a medical examination and to contribute to the superannuation fund.

Applications, stating age, previous experience and present position, accompanied by two testimonials and the names of two persons to whom reference can be made, must be delivered to me not later than the last post on the 15th July in an envelope endorsed " City Engineer."

The gentlemen who sent in applications in reply to the first advertisement need not send in applications again, but must notify me if they desire to be considered.

T. J. OWEN,
Town Clerk.
The Guildhall,
Nottingham. E5245

AIR MINISTRY

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

Air Ministry require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS for design, construction and maintenance of installations on airfields, radar stations, missile bases, workshops and maintenance units for R.A.F. at home and overseas as well as certain Civil Airports. Salary : £805 at 25 to £1095 at 34 or over, thereafter rising to maximum £1260, with increase for London, and slight decrease for country districts. Appointments non-pensionable but long term. Promotion prospects. 5-day week with 4 weeks' 2 days' leave a year initially. Special allowance in addition to salary during overseas service. Qualifications and experience :

(i) (a) University degree or equivalent diploma in electrical and/or mechanical engineering with at least 2 years' apprenticeship ;
or (b) Graduate or corporate member of I.E.E. with at least 3 years' apprenticeship ;
or (c) Graduate or corporate member of I.Mech.E., appreciable electrical engineering experience with at least 3 years' apprenticeship ;
and (ii) Have been employed for minimum of 2 years with well-established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45. Forms from Ministry of Labour, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.158/OA. E9850

BRITISH RAILWAYS

(SCOTTISH REGION)

ASSISTANT WORK STUDY INSTRUCTOR

British Railways require for their Scottish Region Work Study School at Glasgow an ASSISTANT WORK STUDY INSTRUCTOR with sound knowledge of Work Study Techniques and lecturing experience. Practical experience in applying incentive bonus schemes desirable, and applicants should have ability to undertake and supervise Work Study investigations.

Salary £1260 rising to £1490 per annum. Travel facilities. Contributory Superannuation Scheme. Applicants will be in competition with candidates from within the Commission's service.

Applications, stating age, education, experience and qualifications, should be addressed to the General Manager, British Railways, 302, Buchanan Street, Glasgow, C.2. E5247

BOROUGH OF SHREWSBURY
WATER DEPARTMENT

APPOINTMENT OF AN ASSISTANT ENGINEER

Applications are invited for the above established appointment within salary A.P.T. Grade II (£765 to £880) according to qualifications and experience.

HOUSING ACCOMMODATION WILL BE PROVIDED IF REQUIRED AND REMOVAL EXPENSES PAID.

The appointment is subject to the N.J.C. Conditions of Service, the Local Government Superannuation Acts, a satisfactory medical examination, and termination by one month's notice on either side.

Applications, stating age, qualifications and details of experience, together with the names of three persons to whom reference may be made, should be submitted to the Water Engineer and Manager, Water Department, Shelton, Shrewsbury, so as to be received not later than the 6th July, 1960.

S. R. H. LOXTON,
Town Clerk.
Guildhall,
Shrewsbury. E5208

PUBLIC APPOINTMENTS

GOVERNMENT OF JAMAICA

PUBLIC WORKS DEPARTMENT

ENGINEER (REFRIGERATION)

To design and supervise the construction and maintenance of Government air-conditioning and and refrigeration installations.

Contract appointment for 3 years. Salary in range £1050 to £1300 a year. Gratuity 20 per cent of salary. Free passages. Rented quarters.

Candidates up to 50 years must have passed or be exempt from the Associate Membership examination of the Institution of Electrical Engineers or the Institution of Mechanical Engineers, with relevant experience or have equivalent qualification in refrigeration engineering.

Write to Director of Recruitment, Colonial Office, London, S.W.1, giving full names, age, qualifications and experience, quoting BCD.112/32/024/D4. E5274

MANCHESTER CORPORATION WATERWORKS

ASSISTANT ENGINEERS

Applications are invited for the undermentioned appointments in connection with the design and construction of treatment and filtration plant, and large service reservoirs, the reconstruction of existing reservoirs, and the reconditioning of main aqueduct :

Assistant Engineers (Class II) : £785 to £1070.
Assistant Engineers (Class III) : £610 to £880.

Applications, stating (1) age ; (2) education and training ; (3) professional qualifications ; (4) experience in the preparation of plans and construction of waterworks and other civil engineering works, together with the names of two referees, should be addressed to the Engineer and Manager, Waterworks Offices, Town Hall, Manchester, 2, not later than 12th July, 1960. E5219

TENDERS

INDIA STORE DEPARTMENT

FOR THE SUPPLY OF A COMPLETE PLANT FOR THE PRODUCTION OF NITRIC ACID

The Office of the Director General, India Store Department, Government Buildings, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the following :

FOR THE SUPPLY OF A COMPLETE PLANT FOR THE PRODUCTION OF NITRIC ACID.

Specifications, drawings, &c., can be obtained from the co-ordination Department, Bromyard Avenue, Acton, W.3, at a cost of ten shillings per Tender enquiry and is not refundable. Tenders are to be returned to the India Store Department, at the above address so as to reach them by Monday, 10th October, 1960.

Specimen copy of the above specification can be seen at Engineering Branch, India Store Department, Acton, W.3, under the following reference 2021/60/ENG.2. E5263

INDIA STORE DEPARTMENT

TENDER REF. NO. 16041/60/BMB/HAL

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3, invites TENDERS for the SUPPLY of :

TENDER REF. No. 16041/60/BMB/HAL
UNIVERSAL DIAL TYPE MILLING MACHINE. Table 79¾in. by 16¼in. Range 42in. by 14in. by 19in. 1 off.

The Tender forms with Schedules and Specifications which are returnable on 25th July, 1960 may be obtained from the above office (Co-Ordination Branch) on payment of a fee of 10s. (not refundable) for each Tender.

Please quote the above reference number. E5279

EDUCATIONAL

COLLEGE OF AERONAUTICS

ONE-YEAR POST-GRADUATE COURSE IN SPACE TECHNOLOGY

Applications are invited for a course which begins on 10th October, 1960. Applicants should generally be graduates in a branch of science or engineering or have equivalent qualifications.

The course is designed to provide post-graduate training for future workers in the field of Space Technology and will consist of lectures, laboratory demonstrations and research projects conducted under supervision. Students will specialise in one of the Departments of the College, and conduct research, which may be either of a theoretical or an experimental nature, on a topic chosen in consultation with the College staff. In addition to attending lectures in their Department of specialisation, students will be expected to attend selected general lecture courses given by other Departments of the College.

Students who successfully complete the course will be awarded the Diploma of Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E5268 E

A.M.I.MECH.E., B.SC., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus, free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

AN APPRENTICE TRAINING SUPERVISOR

is required by STEWARTS AND LLOYDS LIMITED for their Works at Corby, Northamptonshire.

The supervisor will be on the staff of the Area Training Officer and will be responsible for the general supervision of some 300 apprentices of all grades up to University graduates. He will also share in the general activities of the Training Department.

Essential qualifications are a keen interest in the development and training of young people, a mechanical engineering qualification not lower than Higher National Certificate and a knowledge of the technical education system, and of the requirements for the training of engineers. Age not less than 30 years.

Experience of university life and education, and some knowledge of electrical engineering and/or metallurgy are desirable.

Applications forms, which should be returned within a fortnight of the appearance of this advertisement, may be obtained from the Assistant Director of Training, Stewarts and Lloyds Limited, Broad Street Chambers, Birmingham, 1.

E5284 A

AN ASSISTANT SALES ENGINEER is required by Dresser (Great Britain) Ltd., Clark Bros. Co. Division. This Division is responsible to the United States Parent Company for the marketing of gas engines, motor driven reciprocating compressors, centrifugal compressors and gas turbines, manufactured under license in the United Kingdom and on the Continent. Candidates should be well qualified graduate mechanical engineers aged 28-35. The Company is a well-established European organisation and offers good pay and conditions, with a pension scheme. There are excellent prospects for early advancement to full sales engineering responsibilities.—Apply with full personal particulars and details of experience and previous appointments to Dresser (Great Britain) Ltd., Clark Bros. Co. Division, 197, Knightsbridge, London, S.W.7. E2904 A

EDUCATIONAL

A TEACHING CAREER FOR YOU
TRAIN NOW

Persons aged between about 25 and about 45, with good industrial experience, are invited to apply for training as FULL-TIME TEACHERS OF ENGINEERING SUBJECTS IN TECHNICAL COLLEGES AND SCHOOLS.

EXCELLENT CAREER PROSPECTS

NEXT COURSE : SEPTEMBER, 1960 TO JUNE, 1961

Applicants should hold a suitable qualification, e.g. university degree, associate or graduate membership of a professional institution, Higher National Certificate, Final or Full Tech. Cert. of C.G.L.I.

NO TUITION FEES :

PERSONAL, MAINTENANCE, DEPENDANTS' AND TRAVELLING GRANTS PAYABLE

For details write immediately quoting S/113 to either

The Director, Bolton Training College, Manchester Road, Bolton.
The Director, Huddersfield Training College, Holly Bank Road, Huddersfield.
The Principal, Garnett College, 83 New Kent Road, London, S.E.1.

E5291 E

Classified Advts. continued on page 112

SITUATIONS VACANT

ALLIS-CHALMERS GREAT BRITAIN

has opening for APPLICATION ENGINEER. Duties include application, sales and contract correspondence, cost estimating, design development. Products include vibratory and gyratory screens, crushers, ball mills, &c. for coal, quarry and metal-liferrous mining industries. H.N.C. (Mech.). Previous coal processing experience necessary.—Write or 'phone for application form to Allis-Chalmers Great Britain Limited, 728, Salisbury House, London Wall, London, E.C.2. NATional 0821. E2917 A

ASSISTANT ENGINEER required for Scottish Brewers Limited, Edinburgh, age 30 to 35, minimum qualification B.Sc. (Eng.) or A.M.I.Mech.E. The post involves supervision of construction work and plant installation in branches and depots throughout Britain. Scope for considerable initiative and responsibility. Essential is wide background and general knowledge of, and interest in, mechanical, electrical and building fields. Salary according to experience.—Apply to the Chief Engineer, Holyrood Brewery, 55, Holyrood Road, Edinburgh. E2916 A

BRITISH HYDROCARBON CHEMICALS LIMITED

have vacancies for

MECHANICAL ENGINEERS

at their rapidly expanding Grangemouth Works preferred ages 22-28, but older fully qualified Mechanical Engineers can also be considered. Applicants must have a degree in engineering or have been accepted as graduate members of the Inst. Mechanical Engineers. Practical training can be provided where necessary towards qualifying as A.M.I.Mech.E. Salaries will be in accordance with qualifications and experience, and a non-contributory pension scheme is in operation.—Replies should be addressed to the Administrative Officer, British Hydrocarbon Chemicals Limited, Bo'ness Road, Grangemouth, Stirlingshire.

E5177 A

CHIEF ENGINEER

Applications are invited by a large Company in the Chemical Industry for the post of Chief Engineer, in the London area. Responsibility will be direct to the Works Director for the installation of new plant and improvement and maintenance of existing plant. Applicants should have a good honours degree in engineering and be an A.M.I.Mech.E. with preferably some electrical experience as well. Commensurate salary ; permanent and pensionable appointment.—Applications giving full particulars should be addressed to BOX No. E5264, " The Engineer." A

DETAILER AND DESIGNER required by expanding firm making up-to-date mechanical aids for the Building Industry. Holiday arrangements honoured. —Write, giving full details of experience and qualifications to BOX No. E2903, " The Engineer." A

DEVELOPMENT ENGINEER

Williams (Hounslow) Ltd., Manufacturers of Dyestuffs and Chemicals, of Hanworth Road, Hounslow, Middlesex, require qualified Engineer for development of new projects. Candidates must have several years practical experience in design and operation of chemical plant, and the personality necessary to make a positive contribution to management policy decisions. Excellent opportunities for promotion exist in this rapidly expanding medium-sized organisation. Apply to the Deputy Managing Director.

E2913 A

DRAUGHTSMEN are required immediately to fill vacancies caused by promotion of existing Drawing Office Staff in an organisation which is expanding rapidly in order to deal with an increasing programme of capital development. Men aged 22-30, preferably with experience in chemical plant design, piping and plant layouts, who would welcome the opportunity to work on a variety of projects and are willing to accept responsibility are invited to apply. Excellent conditions, including canteen facilities, and non-contributory pension scheme. Five-day week (36½ hr.), good salary according to age and experience.—Apply in writing, giving full details of age and experience to the Personnel Officer, Midland Silicones Ltd., Barry, Glamorgan. E5281 A

DRAUGHTSMEN, SENIOR DESIGN, required by expanding Company for interesting and varied development work on office and printing machinery. Secure superannuated position with good salary and prospects for persons of experience and ability. Five-day week. Staff canteen.—Apply Mr. L. Parker, Personnel Manager, W. H. Smith and Son (Alacra) Ltd., 53, Park Royal Road, N.W.10. Tel.: ELGar 6555. E5262 A

DRAUGHTSMEN (SENIOR) required immediately and early autumn to cope with increasing demand for industrial air conditioning, fume removal, dust collecting plants, etc. Excellent conditions, top salaries, pension scheme etc.—Write BOX No. E5250, " The Engineer." A

ENGINEER having technical knowledge of heat transfer problems with special reference to evaporative type water coolers required to augment present department unable to cope with increasing demand.—Write BOX No. E5251, " The Engineer." A

ESTIMATING ENGINEER for progressive position with prominent London firm of Land and Marine boiler engineers. Drawing office experience essential ; workshop experience an advantage. Attractive salary commensurate with experience and qualifications.—Write fully, stating age, &c., to BOX No. E5138, " The Engineer." A

GEAR DESIGN ENGINEER required with experience marine gearboxes or V.P. propellers. Vacancy is in busy and expanding Technical Dept. where good salary will be paid for the right man, having H.N.C. or equivalent. Existing holiday arrangements respected. Superannuation scheme. Free life insurance.—Apply : Technical Manager, MODERN WHEEL DRIVE LTD., Lindo Lodge, Stanley Avenue, Chesham, Bucks. E5179 A

IMPORTERS REQUIRE REPRESENTATIVES already calling on Engineering Concerns to carry Welding Cutting Equipment and Machine Tools.—BOX No. E191, " The Engineer." A

GRADUATE ENGINEER : If you have a good honours degree in Mechanical or Electrical Engineering and are about to complete your post-graduate apprenticeship and would like to make a career with the Commonwealth's largest glass manufacturing organisation, you are invited to write about yourself to the Personnel Officer (Graduate Recruitment), Pilkington Brothers Limited, St. Helens, Lancashire. Initially you would be a Technical Assistant in the production department of the works manufacturing toughened glass doors, wall cladding and many other forms of toughened glass. After training in production methods you would be engaged particularly on method development. You would have ample scope for exercising your initiative and later you would have opportunities for promotion in maintenance engineering or production departments, in this country or overseas. E5267 A

INTERNATIONALLY SPONSORED RESEARCH

RESEARCH PHYSICISTS OR CHEMICAL ENGINEERS

Two appointments are open, preferably to First Class Honours men with some research experience or with Ph.D., for a minimum period of three years.

The work, sponsored internationally by industry, is in the field of Combustion and Radiation, bridging the gap between fundamental turbulence theory, physical chemistry and heat transfer on the one hand, and practical engineering application of flames on the other.

These appointments provide an opportunity of meeting scientists from many parts of the world, and perhaps of gaining an international reputation.

Commencing salary will be according to age, qualifications and experience, and would be in the region of £1250 per annum for a man under 30, plus £200 allowance for living abroad.

Applicants should write to Professor M. W. Thring (Dept. of Fuel Technology and Chemical Engineering, Sheffield University), c/o The British Flame Research Committee, 11 Park Lane, London, W.1.

E5255 A

JOHNSON MATTHEY AND CO. LIMITED

have a few vacancies for young men in their engineering factories near London, who wish to make a career in Production Management.

Candidates, who should be between 25 and 30, should preferably have had a recognised engineering apprenticeship and an H.N.C. in Production Engineering. Preference will be given to candidates with some experience of production control in light engineering.—Write, giving full details of qualifications, experience, age, etc., to the Secretary of the Company, 78, Hatton Garden, London, E.C.1.

E5241 A

LEADING BRITISH TRADING COMPANY with Branches throughout Far East and world wide Associated Companies requires a CIVIL ENGINEER under 30, preferably single for employment in Malaya. Candidates should be Graduate or Associate Members of the Institution of Civil Engineers or hold academic qualifications acceptable to the Institution which the successful candidate would be required to join. Considerable knowledge and experience of general Civil Engineering for factories, buildings and allied construction required. Furnished accommodation at nominal rent. U.K. leave. Medical and contributory retirement schemes. Other terms of service to be discussed interview.—BOX No. E5185, " The Engineer." A

MANAGER REQUIRED for London office of manufacturers of Boilers, Pressure Vessels, Evaporating Plants, &c., preferably with Industrial and Marine experience.—Marshall and Anderson, Ltd., P.O. Box No. 8, Manse Road, Motherwell. E2923 A

MIDLAND SILICONES LTD.,

require a

PROJECT ENGINEER

at the factory at Barry, Glamorgan.

Duties include design work on new chemical plant and co-ordinating the tasks performed by other departments. Applications are invited from men aged 30-35 who possess H.N.C. in mechanical or chemical engineering. Several years experience is essential in the design and construction of chemical plant. Good commencing salary and non-contributory pension scheme. House purchase facilities are available.

Midland Silicones Ltd., is the leading producer of Silicones in Europe. It is expected to expand considerably as the range and uses of Silicones increase. It is a member company of the Albright Wilson Group.

Apply to the

Group Staff Officer,
Albright and Wilson Ltd.,
1 Knightsbridge Green.
London, S.W.1. Ref. : 11.

E5246 A

RAYMOND INTERNATIONAL (U.K.) CONSTRUCTION LIMITED

require ENGINEER (preferably Grad. I.C.E. or equivalent with 2 years site experience) for work in their London office on administration of overseas contracts. Permanent post with prospects of work overseas at a later date.
Wingate House, 93-107, Shaftesbury Avenue, W.1.
REGent 7536. E2919 A

SALES ENGINEER, required to promote the sales of a new product which facilitates the erection of steel structures. Experience in the design and erection of structural steelwork and a good knowledge of welding are necessary.—Details of experience and salary required to BOX No. E2891, " The Engineer." A

SENIOR DRAUGHTSMAN, O.N.C. (min.) required. Experience in one or more of the following essential ; Cranes, Excavators, truck-mounted Mobile Cranes and Contractors Plant. Good staff conditions. Pension scheme.—Applications in writing, all relevant particulars and approximate salary required to : Personnel Manager, Ruston-Bucyrus Ltd., Excavator Works, Lincoln. E5215 A

SENIOR ENGINEER required to take charge technically and promote sales of ELECTROSTATIC PRECIPITATION plant with particular reference to steelworks fume problems. Interesting position requiring previous experience and initiative which will be appropriately rewarded.—Write BOX No. E5249, " The Engineer." A

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential, and applicants with general mechanical engineering experience will be favourably considered. The posts offer opportunities and salaries consistent with experience and ability. Modern offices situated in the London, E.C.4 area. Five-day week and superannuation scheme.—Applications, which will be treated in the strictest confidence, guving details of age, qualifications and experience, and quoting ref. LCL/TE1/41, should be addressed to The Group Personnel Manager, LAPORTE INDUSTRIES LIMITED, Hanover House, 14 Hanover Square, London, W.1. E5278 A

SIR WILLIAM HALCROW AND PARTNERS, Alliance House, Caxton Street, London, S.W.1 have vacancies for a RESIDENT ENGINEER and several Assistant Engineers for a harbour project in North Africa, for a CHIEF ASSISTANT and an Assistant Engineer on a harbour project in the Persian Gulf, and for DESIGN ENGINEERS in their London Offices.—Apply in writing with full details, qualifications and experience. E5176 A

SIR WILLIAM HALCROW AND PARTNERS Alliance House, Caxton Street, London, S.W.1, have vacancies for DESIGN ENGINEERS in their London Offices. Salary depending on experience, from £700 to £1400 for ages approximately 22 to 32. Apply in writing giving full information, qualifications and experience. E5239 A

STANDARDS ASSISTANT

The Standards Office of S. SMITH AND SONS (ENGLAND) LTD., require a

YOUNG ENGINEER

aged approximately 20-24 years educated to at least O.N.C. standard. Although Drawing Office experience is desirable, a knowledge of Standardisation is not necessary as training will be given in all facets of the job. The work is interesting, covers a wide field and requires adaptability. The ability to write clearly and concisely is essential.

Applications will be treated in strict confidence and should be made in writing to :—

THE STAFF MANAGER,
S. SMITH AND SONS (ENGLAND) LTD.,
CRICKLEWOOD, LONDON, N.W.2,
quoting reference SM.316.

E5269 A

VACUUM ARC MELTING

Furnace Engineers require young PHYSICIST or ENGINEER, preferably a graduate, to assist in the development of a new section in the Vacuum Arc Melting field. Applicants should have experience in vacuum furnace engineering and techniques and have some knowledge of the metallurgical aspects of vacuum melting. The Engineer appointed will be concerned with sales, design, installation and commissioning. —If you can meet all or part of our requirements, please send full details of your education and subsequent experience.—BOX No. E5256, " The Engineer."

A

SITUATIONS VACANT

ASSISTANT

CIVIL ENGINEERS

Civil Engineers are required by one of the leading United Kingdom manufacturers of iron and steel. Candidates must have had extensive site, survey and design experience in the fields of heavy constructional engineering, excavations, earth-moving and quarrying, soil mechanics, foundations, piling and reinforced concrete work.

Applications will be treated as confidential and should be sent to : BOX No. E5244, " The Engineer."

A

CONTRACTS ENGINEERS

Nationally known company has following vacancies in their modern office in West End of London.

Contracts Engineers capable of taking full responsibility for preparation of large composite tenders and for supervision of resultant contracts.

Engineering assistants for above duties.

Candidates should have mechanical/Electrical background and be interested in commercial work. Associate membership of Institute of Mechanical Engineers and some knowledge of rubber/plastics manufacturing industry desirable but not essential.

Attractive working conditions and salaries with opportunity for advancement for suitably qualified well educated men. Pension scheme. Please apply in confidence with full details of age, training and experience to Box No. E2915, " The Engineer."

A

BICC

have a vacancy in their Manufacturing Engineering Section for a GRADUATE IN PHYSICS, ELECTRICAL OR MECHANICAL ENGINEERING. The work involves development of new machines and new methods or processes. Experience in Rubber or Thermoplastic Cables an advantage but not essential. Age range preferably 23/25 years. Five day week. Superannuation Scheme in operation. Excellent working conditions. Applications in writing stating age, experience and qualifications, to:

THE PERSONNEL OFFICER,
BRITISH INSULATED CALLENDER'S CABLES, LTD., ANCHOR WORKS,
LEIGH, LANCS.

E5284 A

LEO

DRAUGHTSMEN

Excellent prospects are offered to experienced mechanical draughtsmen in the Drawing Office of a small rapidly expanding Company engaged in manufacturing large scale digital computers.

At least two years Drawing Office experience is required together with some practical experience. Starting salaries well above A.E.S.D. rates will be paid and future progress will be very rapid for those with ability. The positions are permanent and pensionable. Existing holiday arrangements will be honoured. Brief details of career to date should be sent to :

Personnel Officer,
LEO Computers Limited,
Minerva Road, North Acton,
London, N.W.10.

E5234 A

SITUATIONS VACANT

Would you like to work in a peaceful atmosphere with beautiful country around you?

Group of Engineering Companies with modern offices in Hereford require:

(1) Technical and Commercial Sales Manager with experience of industrial air conditioning and refrigeration for home and export.

(2) Development Engineer.

(3) Sales Engineers.

(4) Refrigeration, Mechanical and Hydraulic Draughtsmen and Estimators.

5 day week. Contributory pension scheme. Applications, which will be treated in strict confidence, should be made in writing stating age, experience, salary required, &c., to Managing Director, Denco Works, Hereford.

E189 A

SITUATIONS VACANT

AN ARCHITECTURAL or BUILDING DRAUGHTSMAN

is required by

W. H. ALLEN SONS & COMPANY LTD.

for their

WORKS ENGINEERS DEPARTMENT

Experience of architectural and civil engineering design is necessary and it is desirable that applicants should have had some basic technical training.

The Company offers excellent conditions of service, a contributory Pension and Life Assurance Scheme and a comprehensive range of welfare and recreational amenities. Assistance will be given towards expenses involved in moving to the Bedford area, where appropriate.

Applications should be made in writing, giving details of age, past experience and present salary to :

THE PERSONNEL MANAGER
(Ref 1604C/9),
QUEENS ENGINEERING WORKS,
BEDFORD.

E5175 A

SITUATIONS VACANT

TECHNICAL ADVERTISING AND PUBLISHING

U.K. business manager to handle leading technical and engineering journals for syndicate of American publishers now establishing European division. Applicants must have proven sales and technical background in one or more of the following fields :

Petroleum, Chemistry, Marine engineering and Ship Building, Railways, Steel Production and Metal Working, Metallurgy, Industrial Power Equipment. Some knowledge of modern industrial advertising, sales promotion and merchandising desirable but not essential.

Age 30 to 45. Excellent salary. Expenses and participation in profits.

Submit detailed qualifications and experience with photograph if possible to BOX No. E2925, "The Engineer." Interviews in England beginning about July 10.

A

IMPERIAL CHEMICAL INDUSTRIES LIMITED

BILLINGHAM DIVISION AND HEAVY ORGANIC CHEMICALS DIVISION require for their

£30m. expansion programme

MECHANICAL, CHEMICAL AND ELECTRICAL ENGINEERS

The wide variety of engineering work at Billingham offers exceptional opportunities for a worthwhile and progressive career and for obtaining all-round experience in

DESIGN	CONSTRUCTION
DEVELOPMENT	PLANT OPERATION

and engineers in their early years are carefully trained in all facets of their profession for promotion to executive positions in management as well as in technical spheres.

Appointments are pensionable and carry attractive salaries. There is a profit-sharing scheme and assistance can be given to married men towards house purchase and removal expenses.

Applications are invited from ambitious young men aged thirty or under who hold a good Honours Degree in Mechanical, Chemical or Electrical Engineering and who have completed a course of post-graduate training. Write giving brief details of age, qualifications and experience to

THE STAFF MANAGER,
IMPERIAL CHEMICAL INDUSTRIES LIMITED,
BILLINGHAM DIVISION, BILLINGHAM, CO. DURHAM.
Quoting reference S/BB.8.

E5261 A

CIVIL ENGINEERS AND ELECTRICAL ENGINEER

Consulting Engineers require Qualified Civil Engineers between the ages of 26 and 35 with experience of Water Supply or Hydro Electric Schemes for design work in London.

They also require an Electrical Engineer who is a Graduate of the Institution of Electrical Engineers. For design work and inspection of equipment at Works. The vacancy provides a good opportunity for an electrical engineer to obtain mechanical engineering experience.

Salaries according to experience and ability. 5 day week, luncheon vouchers and pension scheme. Write giving full details to Binnie, Deacon & Gourley, Artillery House, Artillery Row, London, S.W.1.

E5280 A

ELECTRICAL ENGINEER

FOR APPLIED RESEARCH

STEWARTS AND LLOYDS LIMITED, CORBY,

invites applications from Electrical Engineers with a degree and/or professional qualifications. The successful candidate will be engaged in applied research connected with the manufacture of steel, steel tubes and manipulated pipework. This appointment offers interesting work, varied experience, excellent working conditions and salary fully in line with achievement so far.

Corby is a new town in Northamptonshire, and housing prospects are favourable.

Candidates are invited to apply in full to the

Manager/Personnel,
Stewarts and Lloyds Limited,
Corby, Northants.

E5270 A

HENRY WIGGIN & COMPANY, LIMITED
HOLMER ROAD, HEREFORD

require a

MECHANICAL ENGINEER

to augment a team of Engineers at present engaged in a substantial expansion and modernisation scheme. This work should lead, in 3/4 years time, to a responsible position in either the Engineering or Production Departments.

Applicants, preferred age 28/35, should possess either an Engineering Degree, Corporate Membership of the Institution of Mechanical Engineers, or equivalent qualification. They should have had a first class practical training. Experience in rolling mills and ancillary equipment, or heavy hydraulic equipment, would be an advantage.

Attractive salaries, commensurate with age and experience, will be paid.

The Company provides excellent Canteen, Recreational and Welfare facilities, operates generous Non-Contributory Pension and Life Assurance Schemes and, in appropriate cases, assistance can be given for housing.

Applications should be made in writing, giving details of education and experience, and should be addressed to The Personnel Manager, quoting Ref. P.8.

E5167 A

VEREENIGING BRICK AND TILE COMPANY LIMITED
SOUTH AFRICA

MECHANICAL ENGINEERING DRAUGHTSMAN

Applications are invited from fully qualified mechanical engineering draughtsmen for whom a vacancy exists with the Vereeniging Brick and Tile Company in South Africa. The company is the largest manufacturer of refractories and earthenware in South Africa. Applicants should be experienced in general mechanical and structural work, also detail work in connection with crushing, screening and material handling plants.

Good prospects for advancement to Junior Engineer level for persons of suitable calibre. Total inclusive commencing salary offered is £1,200 per annum. The passage of the selected applicant and his wife paid. Leave at the rate of 21 days per annum.

Applications giving full details of qualifications and experience and stating marital status, should be forwarded to :—

Vereeniging Brick and Tile Co. Ltd.,
40 Holborn Viaduct,
London, E.C.1.

E5288 A

Classified Advts. continued on page 114

SITUATIONS VACANT

MSL *have been retained to advise on the appointment of a*

TECHNICAL MANAGER

to join the top team of an engineering firm developing, designing and selling mechanical and chemical plant and equipment for large projects on an international scale.

He will be responsible to the Managing Director for the control and guidance of a technical staff of 50 and for the technical direction of all contracts from enquiry to commissioning overseas.

Candidates must hold membership of a chartered engineering institution and preferably a university degree. A thorough knowledge of process working and steam utilisation is essential. Responsibility for technical negotiations on major projects, evidence of advanced design work, and published technical articles are very desirable.

Preferred age 45 to 50 years. Initial salary up to £3,000 with pension, with prospects of a board appointment. Some overseas travel will be necessary.

Please send brief details in confidence, quoting reference G.2491, to J. G. Smith. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

MANAGEMENT SELECTION LIMITED
17, Stratton Street, London, W.1.

E134 A

SITUATIONS VACANT

MSL *have been retained to advise on the appointment of a*

TRAINING OFFICER

for a number of companies with a mutual interest in the training of newcomers to certain divisions of the engineering industry.

He will be responsible for studying the needs of, and existing provisions for, apprentices-in-training and for recommending and encouraging further training developments. He will also concern himself generally with the improvement of training in the engineering industry.

Candidates should be professional engineers with a wide industrial background and a thorough knowledge of training methods. A degree would be an asset.

Preferred age 36 to 42 years. Initial salary up to £1,500, with pension scheme.

Please send brief details in confidence, quoting reference G.2366, to D. C. Duncan. In no circumstances will a candidate's identity be disclosed to our client unless he gives permission after a confidential interview at which he will be given full details of the appointment.

MANAGEMENT SELECTION LIMITED
212, West Regent Street, Glasgow, C.2.

E135 A

SITUATIONS VACANT

SHELL

THE ROYAL DUTCH/SHELL GROUP

offers a career to

MECHANICAL ENGINEERS

in the DESIGN Division

THE HAGUE

HOLLAND

The work is connected with their world-wide activities in the chemical industry.

Honours degree or A.M.I.Mech.E. essential.

Candidates with chemical plant design and/or construction experience would be preferable.

The upper age limit is 34 years, but possibly higher for candidates who have had exceptional experience in this particular field.

Applications in writing with full details of career to :

SHELL INTERNATIONAL CHEMICAL COMPANY LIMITED,
Personnel/Recruitment/HME 16
St. Swithin's House,
London, E.C.4.

E5236 A

'ENGLISH ELECTRIC' (Whetstone · Near Leicester)

OFFERS OPPORTUNITIES TO

ENGINEERS AND DESIGNERS

IN THE FOLLOWING FIELDS

MECHANICAL ENGINEERS

1. Research and Development work on the mechanical components of reactor equipment.

2. Design of conventional plant for nuclear power stations including preparation of specifications, analysis of tenders and associated work up to the site commissioning stage.

3. Examination of the problems associated with fuel element design and development, this should particularly interest people with a knowledge of stress analysis or creep deflection of structure at high temperature.

4. The performance and optimisation studies of nuclear power stations, thermodynamics of gas circuits and steam circuits.

5. Theoretical and experimental investigations associated with heat transfer and gas flow in nuclear reactors.

6. Design and specification of the mechanical equipment associated with the core, fuel handling and control of nuclear reactors.

ELECTRICAL ENGINEERS

1. To develop special apparatus for the use of analogue computers.

2. To develop reactor control systems and electrical components of the equipment.

3. Design and contract engineering in connection with reactor auxiliary plant and reactor automatic control systems. The work involves responsibility for schemes from design initiation to site completion.

4. The design of power systems for nuclear power stations including preparation of specifications, analysis of tenders and associated work up to site commissioning stage.

★ ★ ★

The positions are permanent and pensionable and assistance will be given towards initial accommodation.

Enquiries giving details of past experience, qualifications, age, and current salary (which will be treated in strictest confidence) should be addressed to the

TECHNICAL STAFF OFFICER, DEPT., G.P.S., MARCONI HOUSE, STRAND, W.C.2., quoting reference E1816H.

E5271 A

SITUATIONS VACANT

PRODUCTION ENGINEER

required by Northamptonshire general medium engineering works employing 150 people, must be experienced in progress, Machine selection and planning. Age 35/45. Salary £1,500 plus bonus participation. All replies will be acknowledged.—Box No. E2921, " The Engineer."

A

SITUATIONS VACANT

DRAUGHTSMEN

Draughtsmen are required at the Midlands Research Station, Solihull.

The duties are interesting and will include work on the design of pilot and prototype plant associated with the development of new high-pressure processes for the production of town gas.

Candidates should possess at least an O.N.C. certificate in Mechanical Engineering.

The salary for the appointments, which are pensionable and subject to medical examination, will be within the range of £733–£927 per annum.

Applications, stating age, education and experience, should be addressed to the Industrial Relations Officer,

WEST MIDLANDS GAS BOARD,

6, Augustus Road, Edgbaston, Birmingham, 15.

E190 A

SITUATIONS VACANT

DEVELOPMENT ENGINEER

STEEL WORKS ENGINEERING DEVELOPMENT DEPARTMENT

A vacancy exists in the Development Department of an expanding Steelworks located in Sheffield.

The above is an excellent opportunity for a young Engineer (24-32) who has a good degree in Mechanical Engineering or has already been accepted as an Associated Member of the Institute of Mechanical Engineers ; is looking for a position which requires initiative, and will allow him to develop his own ideas and see them carried through to the completed job.

The Engineer selected will be a man who can show by the work he has already done that he has an inventive mind and a flair for designing plant to meet the widely different requirements encountered in a comprehensive steel plant.

The Company produces a wide range of hot and cold rolled products, drawn bars and sections, rods and wire in mild carbon and stainless steels.

Applications should contain a short personal history and résumé of past experience and be addressed to :

Chief Engineer,
ARTHUR LEE & SONS LIMITED,
P.O. Box 54,
Sheffield, 9.

An attractive salary will be paid to the selected applicant, who will have excellent opportunities for promotion.

E5282 A

PROFESSIONAL ENGINEER

required at

ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL

to be responsible for technicians and skilled workers engaged on the installation, operation and modification of particle accelerators and similar major electro-mechanical plant. Duties involve interesting and novel design work in collaboration with scientific staff.

Applicants should have served a recognised engineering apprenticeship or have had equivalent training. An Engineering degree an advantage.

Several years experience of medium power electrical engineering and familiarity with circuit techniques for sequential and semi-automatic control systems is desirable. Knowledge of high vacuum systems and basic mechanical engineering practice an asset.

SALARY : £860 (at age 25) — £1,340 p.a. or £1,370 — £1,825 p.a. according to age and experience.

Housing and superannuation schemes.

Send POST CARD for details to Personnel Manager (1730/25), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks.

E5235 A

SENIOR PRODUCTION ENGINEER

An experienced production engineer is required to form and lead a team of specialists to engage in pre-production design of mechanisms for manufacture throughout Europe.

The team will be directly associated with a research establishment developing accessory mechanisms for the major European motor industries.

Applicants must have wide experience of economic design for mass production methods associated primarily with light presswork as well as diecasting, plastic moulding or metal sintering processes.

The position calls for occasional journeys to the Continent, and therefore a knowledge of French would be advantageous though not essential.

The Laboratories are in ideal surroundings at Umberslade Park, near Hockley Heath, where working conditions are excellent. Transport is available to and from the establishment.

The post carries monthly staff status, a competitive salary, staff pension scheme, etc.

Applications, which will be treated in strict confidence, stating age and full details of qualifications, experience and current salary should be addressed to :

V. CHANARYN (52U/E), Head of Engineering Development,

WILMOT BREEDEN LABORATORIES,

Umberslade Park, Hockley Heath, Solihull, Warwickshire. E5257 A

CENTRAL ELECTRICITY GENERATING BOARD

RESEARCH and DEVELOPMENT DEPARTMENT

BERKELEY NUCLEAR LABORATORIES

Engineering Division

There are a number of vacancies in the Engineering Division of the Berkeley Nuclear Laboratories now under construction on a site adjacent to the Berkeley Nuclear Power Station in Gloucestershire.

Appointments will be made as soon as possible and successful candidates will in general work initially at **temporary offices in Bristol, transferring to Berkeley** as the Laboratory buildings become ready for occupation towards the end of 1960.

A. THEORETICAL SECTION.

This section will study a variety of nuclear engineering problems and, where necessary, make recommendations for experimental work to be carried out. It will also help in the assessment of the results obtained by the development sections in the Engineering Division.

Applications for these posts are invited from **ENGINEERS** holding honours degrees and Graduate or Corporate Membership of one of the senior Engineering Institutions. They should have experience in at least one of the following fields:— **heat transfer and fluid flow; mass transfer, gaseous diffusion and allied subjects in the chemical engineering field; stress analysis and vibrations; solution of engineering problems by computer methods; nuclear power station design and economic assessments.**

B. HEAT TRANSFER SECTION.

There are a number of vacancies for **MECHANICAL ENGINEERS** with a degree or HNC to work on the general design, specification and subsequent operation of test rigs for development work in reactor core heat transfer.

C. FUEL ELEMENT DEVELOPMENT SECTION.

This section will be concerned with the performance of fuel elements and reactor components under simulated reactor conditions and initially the work will include the outline design of test rigs for this purpose. This development work on fuel elements is of particular interest to mechanical engineers, and physicists or metallurgists with an engineering background. Applicants for these posts should have an Honours degree or equivalent qualification and experience of work in at least one of the following subjects:— **development of component testing rigs; fuel element fabrication; welding of non-ferrous metals; leak detection and vacuum techniques; radiography and metallography.**

SALARIES ACCORDING TO DUTIES AND RESPONSIBILITIES ON A SCALE WITHIN THE RANGE £1,195 — £1,775 p.a.

Applications stating age, qualifications, experience, present position and salary to the Personnel Officer, 24/30, Holborn, London, E.C.1., by 18th July. Envelopes should be marked "Confidential Ref. ENR/236." E5252 A

CALTEX

THE BAHRAIN PETROLEUM COMPANY LIMITED

A POWER STATION ENGINEER is required for the Power and Utilities Department of the above Company's oil refinery in the Middle East. The duties are concerned with high-pressure steam boilers, condensing and extraction turbo-generators and associated plant. Experience in high voltage control, distribution and utilisation would also be an advantage.

Applicants, preferably under 28 years of age, should have had a sound technical training and a minimum of two years experience in steam-operated electric power generating plants and possess at least one of the following qualifications :—

(*a*) Graduate Membership of the Institution of Mechanical Engineers.

(*b*) Graduate Membership of the Institution of Electrical Engineers.

(*c*) B.Sc. Engineering.

The commencing salary will be dependent upon qualifications and experience, and in addition to which free air-conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid home and local leaves (passage paid for the former and generous assistance towards the latter) are also provided with participation in the Pension and Provident Fund Schemes.

Apply in writing quoting " ETS/PU " with full particulars to Caltex Services Limited, Caltex House, Knightsbridge Green, London, S.W.1.

E5258 A

Classified Advts. continued on page 116

SITUATIONS VACANT

SALES ENGINEERS

Continued expansion and promotion within the Organisation has created a number of vacancies in the Field Force of a Leading Machine Tool Importing and Merchanting Company.

It is intended to make Senior appointments in North West (Lancs and Cheshire) and South West England (including West London and Home Counties). Junior posts are vacant in the North West (Yorkshire and Cheshire), and Midland Territories.

Only experienced, well-connected Machine Tool Sales Engineers with first-class record can be considered for Senior Appointments. Junior men must be Apprenticed Engineers up to 30 years of age with sound knowledge of heavy duty machine tools and preferably some selling experience.

Remuneration will be by salary, commission and expenses.

Apply with full details in confidence to Sales Manager, BOX No. E5240, "The Engineer."

A

CHIEF DRAUGHTSMAN

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKSHIRE

to supervise and organise Drawing Office sections engaged on preparing manufacturing drawings and detail design of electro-mechanical, electronic and electrical equipment.

Applicants should have served an engineering apprenticeship or have had at least three years workshop experience and possess an O.N.C. or preferably, H.N.C. Considerable drawing office experience with the ability to control and select staff and a comprehensive knowledge of modern Drawing Office practice, engineering/electronic standards and materials is essential.

SALARY : £1390 to £1680 p.a.

Superannuation Scheme. A house, or substantial assistance with house purchase, will become available for married officers living beyond daily travelling distance.

For application forms send postcard (or letter) to the Senior Recruitment Officer at the above address. Please quote ref. 2704/25.

E5243 A

PATENTS

THE PROPRIETOR of British Patent No. 770363, entitled "BLIND RIVETING," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern and Carlberg, 140 S. Dearborn Street, Chicago 3, Illinois, U.S.A. E5201 H

THE PROPRIETOR of British Patent No. 770,934 for "ULTRASONIC DEVICE," desires to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder.—Further particulars may be obtained from Marks and Clerk 57 and 58, Lincoln's Inn Fields, London, W.C.2. E5254 H

THE PROPRIETOR of British Patent No. 724,037 for "IMPROVEMENTS IN THE PREPARATION AND SUPPLY OF AIR/FUEL MIXTURE TO AN INTERNAL COMBUSTION ENGINE," desires to enter into negotiations with a firm or firms for the sale of the Patent or for the grant of licences thereunder.—Further particulars may be obtained from Marks and Clerk, 57 and 58, Lincoln's Inn Fields, London, W.C.2. E5265 H

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

MOBILE LIFTING SERVICE. Lump Sum or Hire Rate quoted for any lifting work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 78481. E187 MW

MISCELLANEOUS

LUSOL

KILLS RUST AND LUBRICATES

LUSOL The Rust Solvent is invaluable for Dismantling, Repairing and Overhauling Engineering Equipment. Obtainable from your usual Supplier. Enquiries to the manufacturers :—

The Great Eastern Oil Co., Ltd.,

372, Scotland Street, Glasgow. Tel.: South 2207 E184 I

DAVIES INVESTMENTS LTD.,

BANKERS

Continue to offer 7½ per cent. per annum on deposits, with extra ½ per cent. added annually on each £500 unit.

Details from Investment Dept. ER.

DAVIES INVESTMENTS LTD., DANES INN HOUSE, 265, STRAND, LONDON, W.C.2.

E178 I

BUSINESSES and PREMISES

GENERAL ENGINEER, CONSTRUCTION AND QUARRY PLANT. Wilts./Som. border. 1½ acre site, 6250 sq. ft., new modern works, and others. Excellent equipment and plant 5 vehicles. Turnover £23,000. Net profit £4000. Freehold £20,000.—SPA ESTATE AGENCY, St. James's Parade, Bath. Tel.: 64316. E2924 L

BUSINESS OPPORTUNITIES

A BARGAIN. £25 complete. BRAND NEW READY-MADE CO. REGNS. Guaranteed no trading (ENGLAND OR SCOTLAND)—all trades available NOW, including Engineering ; Electrical Engineering ; Motor Engineering ; Garage ; Machinery ; Metal ; Haulage ; Hire Purchase ; Investment ; Property (specially prepared for each trade).—BUSINESS ECONOMY CO. REGNS., LTD., Dept. T/16, 156, Strand, London, W.C.2. (Tem. 8377/2294), for English companies, and to 19, Walker Street, Edinburgh, 3 (Cal. 1167/8/9), for Scottish Companies. Read "ADVANTAGES OF TRADING AS A LIMITED COMPANY" (3s. post free) ; Limited Co. may save you tax. We have seven-day Co. Regn. service with your own choice of name. £21 complete, plus stamp duties. E182 G

REMPLOY SPONSORSHIP SCHEME

Send for details which show an attractive proposition to manufacturers.

Write to the MANAGING DIRECTOR, REMPLOY LTD., 25-28, BUCKINGHAM GATE, S.W.1, or telephone VICtoria 6621 (12 lines).

E9665 O

MACHINERY Etc. WANTED

WANTED—200 ton Double Sided Vertical Press, suitable impact extrusion—8in. stroke—top knock-out.—BOX No. E2914, "The Engineer." F

WANTED

300 / 400 Ton Forging Press, Steam preferred, Hydraulic or Pneumatic considered, for Cogging and Forging up to 10 Cwt. — Box No. E5186 "The Engineer".

F

FOR SALE

SERVICE EDWARDS VALUE!

TAYLOR & CHALLEN No. 5 T.D.P. Double Sided Double Action Toggle Drawing Press, motorised for 440/3/50 supply, punch stroke 12in., blank-holder stroke 6½in., between uprights 30in., bed to guides 23in., bed 27½in. diameter, hole in bed 18½in. diameter, weight approximately 196 cwt.

CRAIG & DONALD Type 6-26. Double Sided Power Press, motorised for 415/3/50 supply, pressure exerted 150 tons, stroke 5in., between uprights 26in., bed to guides 14¾in., bed 26in. by 30½in., hole in bed 20in. by 21in., weight approximately 9½ tons.

JOHN HANDS Double Sided Friction Screw Press, motorised for 400/440/3/50 supply, pressure exerted approximately 60 tons, maximum stroke 18in., between uprights 37½in., bed to guides 7in., tee slotted bed 36in. by 46in., weight approximately 9½tons.

PELS Double Ended Universal Punching, shearing and section cropping machine, motorised for 400/440/3/50 supply, punches up to 1¾in. diameter by 1in. thick, depth of punch gap 24in., shears flat bars up to 1in. thick, crops rounds, tees, squares and angles in proportion, weight approximately 8 tons.

RHODES No. 21 size Inclinable Power Press, motorised for 420/3/50 supply, pressure exerted 30 tons, stroke 3½in., bed 28in. by 18½in., hole in bed 16in. by 12in., with automatic safety guard, weight approximately 47 cwt.

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July 19-20	Miscellaneous stores and vehicles.	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS, LTD. (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73).
July 26	Machine tools and miscellaneous stores.	M.O.A. Storage Depot, Byley, Nr. Middlewich, Cheshire. (Sale at Cheetham Town Hall, Manchester, 8).	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373).
August 16	Miscellaneous stores.	M.O.A. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272).
August 23	Miscellaneous stores.	Central Ordnance Depot, Didcot, Berks.	SIMMONS & SONS (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025).
September 1	Vehicles, machine tools and miscellaneous stores.	M.O.A. Storage Depot, Bowhouse, Hurlford, Nr. Kilmarnock, Ayrshire.	DIXON & WALLACE, LTD (Dept. L), Bank Buildings, Graham Street, Glasgow, E.1. (Tel.: Bridgeton 2447/9).

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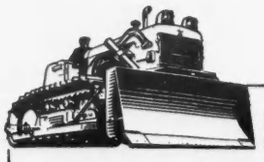

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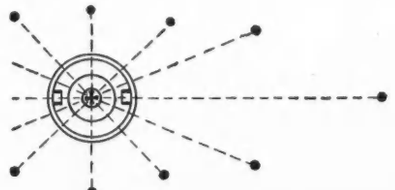

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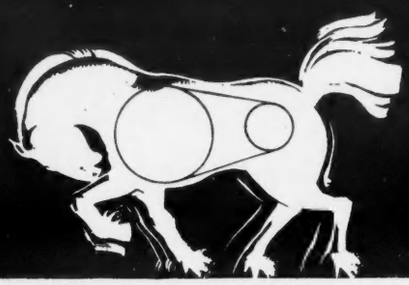

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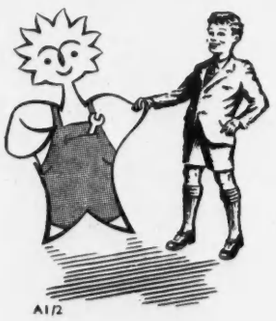

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